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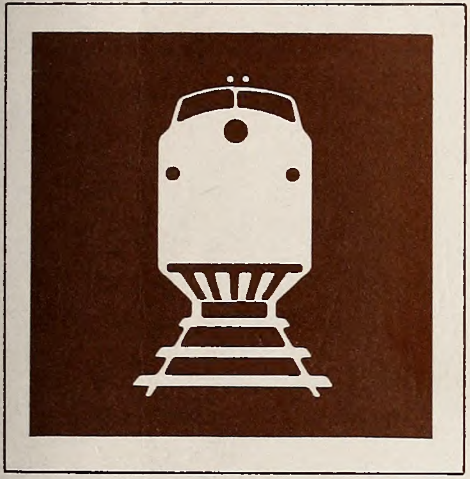

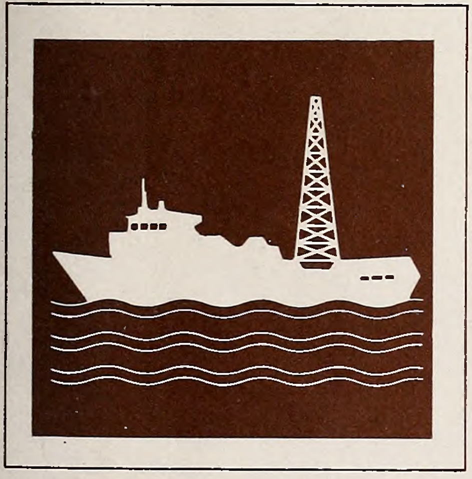

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Cumulative Impacts of Peat Mining
Final Project Report

OCT 8 1984

Edited by
Judith A. Gale
David A. Adams
Department of Forestry
North Carolina State University

AUGUST 1984

North Carolina
Coastal Energy Impact Program
Office of Coastal Management
North Carolina Department of Natural Resources
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FINAL PROJECT REPORT

Edited by

Judith A. Gale

and

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Raleigh, NC 27695-8002

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1. ABSTRACT

1.1 Description of the Project

Three alternative 20-year peat mining development scenarios and a no change alternative were constructed for a study area consisting of Hyde, Tyrrell and Washington Counties, North Carolina. The scenarios included: 1) currently permitted acreage mined as proposed (as of summer, 1983) (22,690 acres permitted and 17,360 acres mined during a 20-year period); 2) upper boundary (84,000 acres permitted and mined); and 3) industry failure at year 10 (22,960 acres permitted and 8,520 acres mined by year 10).

Probable cumulative environmental and economic impacts associated with each scenario were examined. These included impacts on agriculture; forest products; fish; wildlife; recreation; surface water runoff; nutrient, trace element, coliform bacteria and pesticide yields; groundwater; land use conversion; air quality; solid waste; occurrence of fire; and local economics.

Critical potential impacts of peat mining and related land conversion activities were identified and recommended approaches to address these impacts were outlined. In cases where impacts from other forms of land conversion, such as agriculture and forestry, were believed to be similar to impacts of peat mining, the recommended approach was broadened to address impacts of land conversion in general.

1.2 Critical Impacts and Recommended Approaches

1.2.1 Estuarine Impacts

Large-scale conversion of peatlands to agriculture, forestry and peat mining on the Albemarle-Pamlico Peninsula will alter primary nursery areas in peripheral estuarine systems. Changes in salinity regimes; surface water runoff rates; nutrient loading; suspended solids; sedimentation; trace element, pesticide and coliform bacteria levels; and interactions among these factors are believed to be the most significant potential estuarine impacts from land conversion.

The recommended approach includes the initiation of an integrated, multidisciplinary effort toward: 1) identifying the most significant gaps in data relating to the estuarine impacts described above and 2) developing a predictive numerical model for use by decision makers in assessing the impacts of existing and proposed coastal land use on the state's estuarine resources. Such a model could also be used to support effluent limitations to meet water quality standards for primary nursery areas.

1.2.2 Wildlife

A wildlife habitat simulation was used to analyze the consequences of large-scale peat mining on the Albemarle-Pamlico Peninsula. A significant proportion of the currently existing black bear and bobcat habitat will be lost if extensive mining takes place.

Field validation of habitat suitability indices for important species used in the simulation is needed. In addition, linking of the spatial and temporal aspects of the wildlife habitat simulation model is necessary to enable land managers to evaluate the impacts of alternative land use decisions on wildlife.

1.2.3 Upland Water Management

Extensive peat mining may increase annual runoff from the mined areas by up to 30% above the pre-mining flow. As the mined areas are reclaimed to agriculture and forestry, annual flows will decrease or increase slightly from the pre-mining flow, depending on the crops planted.

Impacts of drainage systems and seasonal pumping on the location of the fresh/saltwater interface in estuarine areas are not known.

The cumulative impacts of groundwater withdrawals for peat processing and drainage from mining sites are not well understood. However, the potential exists for saltwater intrusion into areas where peat is mined close to and below sea level.

Further research is needed in the following areas: hydrology of undisturbed peatlands; nutrient transformation in canal and river networks; field measurement techniques and modeling of surface runoff from actively mined sites; long-term effectiveness of wetland buffers for filtration of nutrients, trace elements and sediments and for control of freshwater flow rates; effectiveness of storage lakes in reducing negative estuarine impacts of land drainage; and effects of peat mining on groundwater supplies, including the location of the fresh/saltwater interface.

The data from the research listed above will provide input to an existing hydrological model estimating the effects of alternative upland water management strategies on surface runoff. The output from this model could provide input to an estuarine model.

1.2.4 Hurricane Flooding

Approximately one-half to two-thirds of the Albemarle-Pamlico Peninsula is subject to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year.

Hurricane tides may push saline water from the sounds up rivers and canals into low lying areas created by peat mining, damaging areas reclaimed to agriculture and forestry. In addition, the effects of hurricane flooding on shallow aquifers under such conditions is not known.

Rain associated with hurricanes may accumulate in low lying areas faster than the capacity of pumps to remove it. Thus the potential also exists for freshwater damage to crop and forest land, depending on the duration of the flooding.

The recommended approach is to develop a new series of maps delineating flood susceptibility based on land elevations that would exist if substantial peat deposits were removed from the region. Sediments underlying the peat deposits should be examined to determine their susceptibility to floodwater infiltration.

1.2.5 Unique Natural Areas

Large-scale peat mining on the peninsula will be accompanied by a loss of part of the state's largest and least disturbed wetland complex, and a large proportion of the area underlain by peat of depths greater than four feet. Some of these areas contain prime Atlantic white cedar habitat. Extensive mining will remove a significant proportion of these unique areas and the biota they support.

An attempt should be made to determine if the peninsula contains other areas that are unique in biological, hydrological, geological, pedological, chemical or other natural aspects and worthy of consideration for preservation or protection.

1.2.6 Air Quality

The cumulative effects of multiple source air pollutants (from peat harvesting and multiple stacks) from large-scale peat mining and processing on the peninsula are not known and should be monitored and modeled to assess potentially negative impacts.

In addition, refinement of emissions estimates is needed to determine whether fugitive dust emissions during peat mining and transport and storage of peat will have significant negative impacts if extensive mining occurs.

1.2.7 Solid Waste

The capacity of potential disposal sites on the Albemarle-Pamlico Peninsula to handle the volume of non-hazardous waste that would be created by extensive processing of peat on the peninsula is uncertain. Additional research on site selection and evaluation for solid waste disposal is needed.

Impacts of onsite use of some of this waste, for example, on roadbeds or for agricultural land treatment, are not well documented. Further characterization of the properties of leachates of peat combustion ashes is needed to adequately evaluate the impacts of such practices.

1.2.8 Local Economics

Fiscal problems may arise when new residents (migrating to the area to work in peat mining operations) locate outside the political boundaries of local governments having the power to tax peat mining facilites. Distributional aspects of tax revenues and public services required may create deficits in some cities and counties and surpluses in others. Short-term fiscal problems may also arise where generated revenues lag costs.

The development of two simulation models is recommended: 1) a model to address the impact of potential peat mining facilities on tax rates and revenues and 2) a model to examine the overall fiscal impacts of peat mining on state and local government.

In addition, the economic consequences of large-scale peat mining and other land conversion activities in coastal areas on the recreation, tourism and commercial and sport fishery sectors should be examined.

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2. INTRODUCTION

2.1 Origin and Background of the Study

The Albemarle-Pamlico Peninsula of North Carolina lies in a region characterized by low surface elevations, a water table that lies close to the surface and extensive wetlands (Heath, 1975). The peninsula contains about 582 square miles (373,000 acres) of peat deposits that occur in shallow depressions to a depth of 10 feet and in narrow former stream channels to a depth of 16 feet (Ingram and Otte, 1982).

During the past 10 to 20 years, increasing concerns in the United States relating to energy sources and availability have led to heightened interest in the potential of peat as a fuel. North Carolina peat is characterized by low ash and sulfur contents (usually less than 10% and 0.5%, respectively) and a high heating value (median heating value: 10,200 Btu/lb) (Ingram and Otte, 1981). Its quality is thus high as a fuel for direct combustion. The low bulk density of peat, however, renders the economic feasibility of transporting it any significant distance questionable. Other potential uses of peat include chemical feedstock for the production of methanol, benzene, peat coke, activated carbon, synthetic gas and gasoline, tars and phenols; absorbent; and insulating material (Ingram and Otte, 1981).

In response to growing interest in peat mining, the North Carolina Department of Natural Resources and Community Development (NRCD) organized a task force in December 1980 to review the status of peat mining activities in the state, evaluate the adequacy of state government's management of this activity, and recommend actions to be taken by NRCD.

Four peat mining permits had been issued for areas located on the Albemarle-Pamlico Peninsula, as of April, 1984. These permits cover 22,960 acres in Hyde, Tyrrell and Washington Counties. Mining for horticultural peat is already occurring on a small scale and a 300-acre experimental mine has been operated since 1978 to test mining equipment and methods.

After studying the legal and regulatory aspects of peat mining, the Peat Mining Task Force (1983) concluded that the state has an adequate framework for the management of peat mining through provisions of the Mining Act of 1971 and permits for water use, wastewater discharge, air quality management and coastal development. However, in its analysis, the Task Force cited the urgent need for additional research and policy development on the long-term cumulative effects of peat mining and related land conversion operations as those activities become widespread in the coastal region. The cumulative impacts of multiple mining and related developments are believed likely to extend beyond the scope of regulatory permits applied to individual establishments. In response to the issues raised by the task force, the Cumulative Impacts of Peat Mining Project was initiated in June, 1984.

This study is part of an ongoing effort by the North Carolina Department of Natural Resources and Community Development, federal agencies concerned with natural resource management, such as EPA, the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service, scientists and industry to identify significant negative impacts of land conversion in coastal areas and to develop means for avoiding or mitigating such impacts. For example, the Governor's Coastal Water Management Task Force was established in 1981 to assess and seek resolutions to conflicts between the interests of those involved with agriculture and forestry, in clearing and draining coastal land, and the interests of those concerned with fisheries and wildlife, in maintaining productive saline nursery areas and wildlife habitat. The task force has made a number of recommendations to the Governor toward this goal (1982, 1984), some of which have already been implemented. The impacts of large-scale coastal land conversion to agriculture have been further explored in a draft environmental impact statement prepared by the U.S. Army Corps of Engineers, Wilmington District (1982), in response to an application by Prulean Farms, Inc. for a Section 404 permit to place excavated materials in wetlands as part of a project to clear and drain areas for agricultural operations in Dare County.

2.2 Funding and Organization of the Study

The Cumulative Impacts of Peat Mining Project was financed through a Coastal Energy Impact Program grant provided by the North Carolina Coastal Management Program, through funds provided by the Coastal Zone Management Act of 1972, as amended, which is administered by the Office of Coastal Management, National Oceanic and Atmospheric Administration. The project was administered by the Water Resources Research Institute of The University of North Carolina. Project Coordinator Dr. David Adams of the Department of Forestry, North Carolina State University, directed the efforts of a research team consisting of faculty and staff members from North Carolina State University, the University of North Carolina at Chapel Hill, East Carolina University and Duke University (see section 8).

2.3 Tasks

The one-year project was charged with four tasks:

1. Construct alternative 20-year peat mining development scenarios (Alternative Scenarios).
2. Identify and assess the probable environmental and economic impacts associated with the alternative peat mining development scenarios (Environmental Assessment).

3. Identify critical impacts that should be addressed in an evaluation plan (Scoping Process).

4. Design a real time evaluation process to address the critical cumulative impacts identified in the scoping process, reviewing existing monitoring programs and identifying specific needs for further research (Evaluation Process).

2.4 Study Area

The primary study area for Tasks 1 and 2 (see sections 5 and 6) of the project encompassed Washington, Tyrrell and Hyde Counties (Figure 2A); however, when cumulative impacts were believed to affect an area larger than these three counties, the study area was enlarged. For Tasks 3 and 4 (see section 7), the study area was expanded to include Dare County and the scope of the study was expanded to include other forms of land conversion, when effects of other land conversion activities (e.g., large-scale agriculture and silviculture) were believed to be similar to impacts of peat mining.

2.5 Scope and Limitations of the Study

In assessing the cumulative impacts of each scenario, the project's research team members have made and stated additional reasonable assumptions as necessary to conduct their analyses. In some cases the assumptions made by team members have not been identical. Attempts have been made to ensure that assumptions made are not contradictory; however, because of the extremely short time frame of the project, it was not possible to revise analyses to render all assumptions identical.

Analyses performed and conclusions reached in the environmental assessment (section 6) are admittedly based on insufficient data and inadequate models. The team elected to proceed as far as possible within project constraints, acknowledging that much of their work would be subject to professional criticism but believing that state-of-the-art analyses with existing data bases, yielding concrete results, were preferable to generalizations, rationalizations and delays. Thus the conclusions discussed here should be viewed as preliminary best estimates. Hopefully, the weaknesses in data and methodology exposed in this work will lead to improvements in the environmental assessment process and to a better understanding of the biophysical and socioeconomic processes operative in the project area.

2.6 Abbreviations

Abbreviations used in this report are listed in Appendix 10.10.

2.7 Use of the Term "Wetlands"

Except where otherwise noted, the term "wetlands" is used in this report in a general ecological sense, and does not imply any particular regulatory meaning.

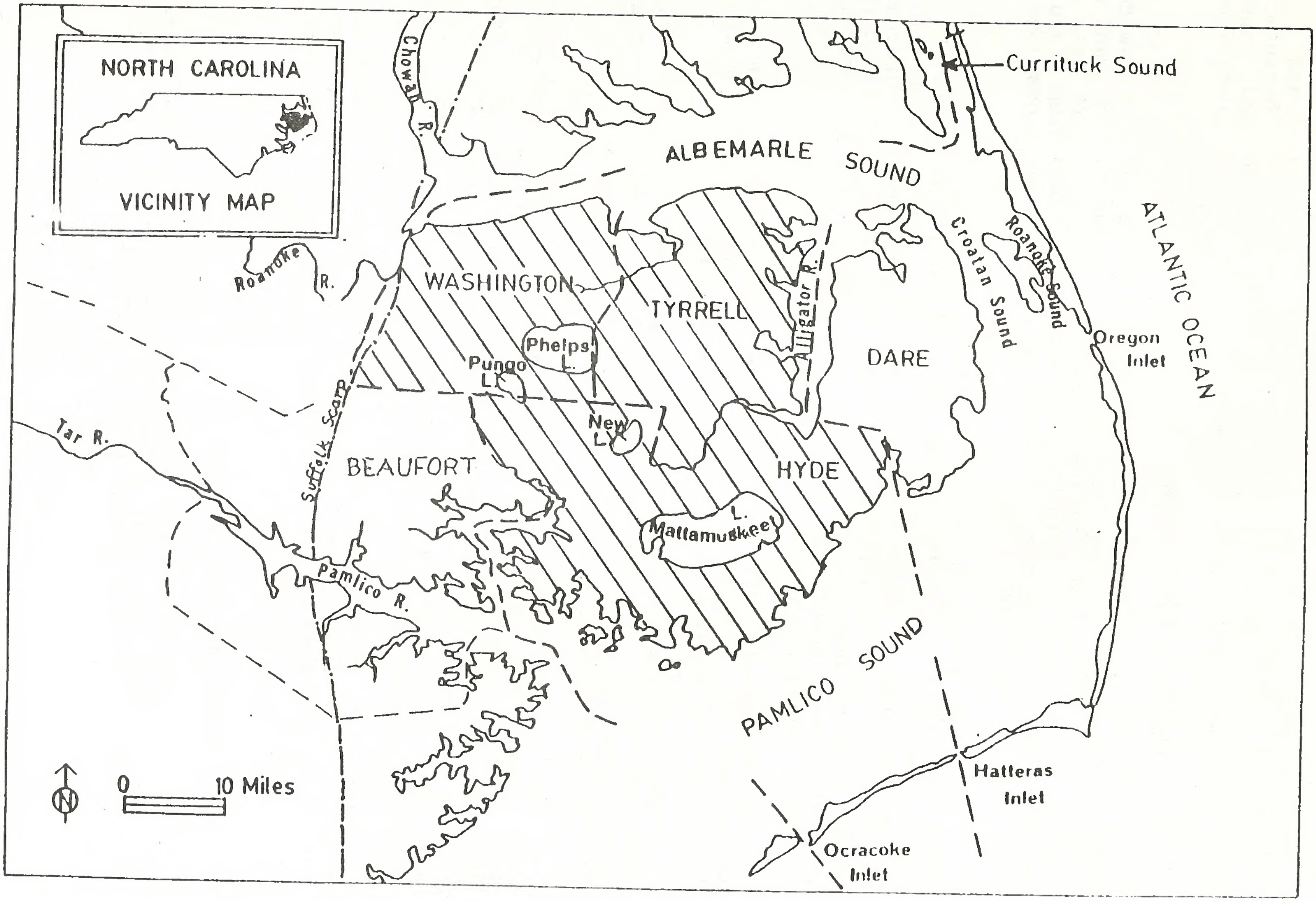

Figure 2A: Location map showing the Albemarle-Pamlico Peninsula and the project study area: Hyde, Tyrrell and Washington Counties

3. SUMMARY

3.1 Affected Environment

3.1.1 Biophysical Environment

The Albemarle-Pamlico Peninsula is a low lying, tidewater region bordered by two sounds, Albemarle and Pamlico, and an estuarine river, the Pamlico (see Figure 2A). The area is characterized by poorly integrated coastal streams, deep organic soils, extensive swamps, marshes and evergreen wetlands, and a low astronomical tidal range.

Drainage projects aimed at lowering the water table and removing surface water in peatlands on the peninsula have been undertaken to enhance agricultural and lumbering operations since the late 1700s. The historical development of drainage systems in the area has been documented by Heath (1975), Lilly (1981), Richardson (1981, 1983) and McMullan (1984). Drainage patterns have thus been altered over the years by a widespread system of canals, ditches and associated roads.

Approximately 20% of the land area on the peninsula was cultivated in 1978-79. Forests cover roughly 70% of the area. Most forested areas occur on deep organic soils.

The peninsula contains approximately 582 square miles (373,000 acres) of peat deposits ranging in depth to 16 feet. The volume of these peat resources has been estimated at 278 million (dry) tons.

The Albemarle-Pamlico Peninsula is considered one of the most productive areas in the state in terms of the richness of its wildlife resources. Four National Wildlife Refuges, a state park and a state gameland are located on the peninsula.

Pamlico Sound and its tributaries constitute the most productive fisheries resource in North Carolina.

The air quality on the peninsula meets or exceeds that required by national air quality standards, and the peninsula has been designated a Prevention of Significant Deterioration (PSD) area.

3.1.2 Socioeconomic Environment

The Albemarle-Pamlico Peninsula is sparsely populated and has few cities and towns. The regional growth rate is 5.1%, one-third of the state growth rate for 1970-80.

Agriculture, forestry and fishing have traditionally dominated economic activity on the peninsula; however, in recent years the composition of the labor force has shifted toward employment in the industrial and service sectors.

Median family income for Hyde, Tyrrell and Washington Counties in 1970 ranged from $4,000 to $7,000 per year. In 1970, 24-38% of the families in the three counties fell below the poverty line.

Commercial fishing in the three counties produced fish and shellfish worth $4.5 million in 1980, while agricultural products were estimated at $42.3 million. Forestry output in 1982 was approximately $3.9 million.

Highway access in the region is good east-west and limited north-south. Water access is good via the sounds and the Intracoastal Waterway (IWW), which bisects the peninsula. Rail access is available only at the western end of the region. No petroleum product pipelines exist in the area, and Dare and Tyrrell Counties have no natural gas service.

3.1.3 Legal-institutional Environment

The major state regulatory tool for the control of environmental impacts of peat mining is the Mining Act of 1971. Other state laws mandating regulation and permitting of certain aspects of peat mining include the Water Use Act of 1967 (groundwater withdrawals in excess of 100,000 gallons per day in a designated capacity use area) and the Coastal Area Management Act of 1971 (development in designated Areas of Environmental Concern).

The scope of federal jurisdiction over peat mining activities is established by the Clean Water Act (NPDES permitting of wastewater discharges, which is administered by the state, and Section 404 dredge and fill permitting administered by the U.S. Army Corps of Engineers), the Clean Air Act, the National Environmental Policy Act, and the Endangered Species Act.

Possible county responses to peat mining include local environmental impact statements, adoption of land use ordinances requiring county mining permits, and severance taxes (if authorized by state enabling legislation).

3.2 Alternatives

3.2.1 No Change

The no change alternative assumes that no peat mining occurs on the permitted area and that the area is not developed further for any other use during the 20-year period of study.

3.2.2 Scenario #1: Currently Permitted Acreage

Scenario #1 is based as much as possible on the plans of peat mining permit holders or companies that have submitted peat mining applications for land located in the study area. When no specific plans were available for a particular aspect of the scenario, "reasonable" assumptions were made.

In this scenario, 22,690 acres are permitted for peat mining and 17,360 acres are actually mined in two areas over a period of 20 years (see Figures 5A and 5B). By year 20, 12,480 acres have been reclaimed, primarily to row crop agriculture requiring pumping (to maintain acceptable canal water levels). Ten percent of the reclaimed land has been re-established to native vegetation and 10% has been reclaimed to low intensity managed forests (pine plantations).

Minimum elevations of mined areas range from 1 to 12 feet above mean sea level, depending on original surface elevation and depth of the peat deposit.

Annual volume of peat mined in Scenario #1 (Areas 1 and 2) averages 665,000 dry tons, or 1.1 million tons at 40% moisture. Seventy-five percent of this peat is converted to methanol, 21% is exported as peat for industrial use (as fuel), and 4% is exported as horticultural peat.

3.2.3 Scenario #2: Upper Boundary

Scenario #2 assumes that most peat deposits greater than or equal to four feet in depth in the study area are mined during the 20-year period (see Figures 5F and 5G). Exceptions are deposits within one-half mile of open water.

Four mining areas are outlined based on drainage characteristics and geographical location. Areas 1 and 2 of this scenario are expansions of Areas 1 and 2 in Scenario #1. Areas 3 and 4 of Scenario #2 are areas for which no mining permit applications have been submitted to date, but in which substantial peat deposits are located.

Scenario #2 is based entirely on assumption and does not represent the stated plans of any peat mining industry or landowner in the study area.

By year 20, 84,000 acres have been mined and 68,600 acres reclaimed, primarily to row crop agriculture requiring pumping and to open water. At least 10% of each area has been reclaimed to native vegetation and at least 10% to low intensity managed forest (pine plantations).

Minimum elevations of mined areas range from 4 feet above to 9 feet below mean sea level, depending on surface elevation and depth of the peat deposit.

Annual volume of peat mined in all four areas of Scenario #2 averages approximately 2.1 million dry tons (3.5 million tons at 40% moisture) at year 10 and 6.6 million dry tons (11 million tons at 40% moisture) at year 20. By year 20, 63% of the peat mined is being converted to methanol, 35% is exported as peat for industrial use (as fuel), and 2% is exported as horticultural peat.

3.2.4 Scenario #3: Industry Failure

Scenario #3 is based on Scenario #1, with assumptions for years 1 through 10 identical in the two scenarios (see Figures 5B and 5H). In the third scenario, however, the peat mining industry fails at year 10. Acreage mined through year 8 is reclaimed according to schedule, but acreage mined in the last 2 years is abandoned. All pumping ceases at year 10, and by year 20, all mined and reclaimed acreage has flooded.

The course of events outlined in Scenario #3 between years 11 and 20 is based entirely on assumption.

3.3 Primary Environmental Impacts of the Alternatives

3.3.1 Amount of Runoff

In all scenarios, runoff from a 2,000-acre mining block will increase from 1,046 million gallons per year (mgy) to 1,336 mgy during mining, and then decrease to 808 mgy on lands reclaimed to agriculture.

In Scenario #3, between years 11 and 20, drainage ditches will become clogged with sediment and debris. All mined acreage will gradually become flooded, remaining open water or becoming swamp. Total annual runoff for both areas (Scenario #3) by year 20 will be roughly equivalent to rainfall minus lake evaporation. When the water level of the lakes becomes high enough, the runoff will flow overland in a direction determined by the slope of the land.

3.3.2 Wastewater Discharges

Wastewater discharges from the methanol plant (Area 1) in Scenario #1 will average 870,000 gallons per day. Discharges will be the same in Scenario #3, but will cease at year 10.

Average daily wastewater discharges from methanol plants in Area 1 and 3 (Scenario #2) will reach 3.1 to 4.1 million gallons per day by year 20.

3.3.3 Groundwater

For all scenarios, in areas where peat is removed, groundwater levels will decline by the depth of peat mined. Re-establishment of vegetation will cause the groundwater level to drop an additional foot. In Scenario #3, surficial groundwater levels will return to pre-mining conditions following failure of the industry and cessation of pumping.

No perceptible change in recharge to the Castle Hayne Aquifer will occur as a result of peat mining in the permitted areas in any scenario.

No significant lateral movement in the fresh/saltwater interface in the aquifers underlying any area of the scenarios will occur as a result of mining or processing operations.

In Scenario #2, Area 1, localized upconing of brackish water may occur at production wells if groundwater is withdrawn from the Castle Hayne Aquifer. In Area 3, localized upconing of brackish water may occur at production wells if groundwater is pumped from the Yorktown or Tertiary Sand Aquifer.

3.3.4 Hurricane Flooding

Area 1 (all scenarios) is not susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year (see Figure 5D). Approximately 50% of Area 2 (all scenarios) is susceptible to such flooding in the absence of protective barriers.

For Areas 3 and 4 (Scenario #2), approximately 75% and 100% of the land area, respectively, is susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year (in the absence of protective barriers).

3.3.5 Air Quality

State air quality standards for particulates will not be exceeded by the mining or processing operations in any of the scenarios if adequate buffer strips and appropriate spacing of methanol plants (as determined by computer simulations) are instituted and necessary mitigative measures are used.

3.3.6 Solid Waste

In Scenario #1 (and Scenario #3 through year 10), approximately 851,000 cubic feet per year of non-hazardous waste and 1,000 cubic feet per year of hazardous waste will be generated in Area 1. Mining operations in Area 2 will not generate any significant amount of waste material.

In Scenario #2, approximately 7 million cubic feet per year of non-hazardous waste and 8,200 cubic feet per year of hazardous waste will be generated by year 20 in Areas 1 and 3. Mining operations in Areas 2 and 4 will not generate significant amounts of waste material.

3.4 Cumulative Environmental and Economic Impacts of the Alternatives

3.4.1 Agriculture

Net annual income (minus drainage cost and based on the prices stated in the assumptions in section 6.1.1.1.1) resulting from reclamation of mined lands to agriculture in both areas of Scenario #1 is estimated at $232,000 - $677,000 at year 20. In all four areas of Scenario #2, net annual income from row crop reclamation of mined lands is estimated at $1.1 - $3.3 million at year 20. For both areas in Scenario #3, increased agricultural production due to reclamation will produce a net annual income of $36,000 - $107,000 at year 10, after which pumping ceases and all mined lands gradually become flooded.

Cumulative impacts of the mining projects under Scenarios #1 and #2 will be a net gain of between $2.9 and $6.9 million or $9.1 and $22 million, respectively, to the local agricultural economy over the 20-year period. Under Scenario #3, the local agricultural economy will lose between $114,000 and $278,000.

3.4.2 Forest Products

The peat mining and reclamation activities outlined in the scenarios will have no significant negative economic impact on the forestry production value of the study area. However, removal of large areas of deep peats will result in the loss of a significant proportion of the state's prime Atlantic white cedar habitat.

3.4.3 Fish

Impacts on the fisheries of Area 1 (all scenarios), will be related to reduction of stream flows during much of the year in the canals and low order streams that provide fish habitat in this area. Accelerated removal of waters in late winter and spring may limit migration and spawning of some species, but no significant effects on anadromous species in this area or on the fisheries of Lake Phelps or Pungo Lake are anticipated unless greater seepage from the lakes occurs or there is increased sedimentation due to wind blown material. Increased sedimentation due to wind blown material could be a significant problem to Lake Phelps since the present levels of suspended residue in this lake are extremely low.

Impacts in Area 2 (all scenarios) will be similar to those in Area 1. Effects on Lake Mattamuskeet fisheries will be negligible. However, increased freshwater flows to the Intracoastal Waterway and to Pamlico Sound via the Pungo River and Albemarle Sound via the Alligator River in periods of high flows and reduced flows and seepage during low flow periods may adversely affect estuarine nursery areas. Increased nutrients in drainage waters and siltation due to high volume water movements may also impact nursery areas.

Impacts on fisheries due to mining and reclamation activities in Areas 3 and 4 (Scenario #2) are not known.

The abandonment of mining areas in Scenario #3 will probably result in the development of fish populations similar to those of Pungo Lake, depending upon size, depth and quality of the water bodies created. Abandoned drainage canals may be used by anadromous and catadromous fish, depending on flows and the extent of clogging in the canals.

3.4.4 Wildlife

Of the ten species evaluated, pine warblers and hairy woodpeckers will sustain the greatest overall habitat degradation (generally 50-60%) under conditions created by the scenarios. However, both species are relatively common, widely distributed and tolerant of human activity. Thus no population of either species will be jeopardized.

Black bears and bobcats will sustain proportionately less loss (generally 20-40%). These species are much more narrowly distributed, and the bear is particularly intolerant of disturbance and human activity.

The marsh rabbit, widely distributed through the lower Coastal Plain, will be moderately, though variably, impacted by peat mining and reclamation activities created by the alternative scenarios.

Whitetail deer and the great horned owl will be only slightly affected by mining activity, except in Area 4 of Scenario #2, where residential development and open water reclamation will decrease available habitat.

Species benefitting from the mining and reclamation activities will include muskrat, bobwhite and mourning dove.

3.4.5 Recreation

Lost recreational hunting value over the 20-year mining period due to land conversion in Scenario #1 is estimated at roughly $513,000 (based on a $5.00 value per hunting trip and assuming that croplands are not accessible to hunters).

For Scenario #2 (all areas) lost recreational hunting value over the 20-year mining period is estimated at approximately $2.6 million.

3.4.6 Amount of Surface Water Runoff

The average annual total flow over the 20-year mining period in Area 1, Scenario #1, will not vary by more than about 5% from the pre-mined condition. A slight steady decline in the total annual water loss from the area will occur as the proportion of the area reclaimed in row crops increases. However, a slight increase in runoff will follow the abandonment of the large area of temporary evaporation ponds (2550 acres) in favor of the smaller permanent lake (1450 acres).

In Area 2 (Scenario #1) the initial increase in total annual flows will be greater than for Area 1 because there will be no storage lake. Once the maximum disturbed area has been reached, total flows will level off as the area of reclaimed land slowly increases. Once all mined acreage has been reclaimed, the average flow will drop to close to or below pre-mining levels, depending on crops planted and drainage systems installed.

In both areas of Scenario #1, the major factor controlling the occurrence of floods will be the capacity of the pumps removing water from the canal system to the lakes (Area 1) and the Intracoastal Waterway (Area 2). If water can not be pumped into the deep storage available in the lake (Area 1) at a high enough rate during high rainfall events, the canals may be breached, causing flooding. However, because of the low lying aspect of the mined land in relation to the surrounding terrain, the flooding involved should remain localized for most events.

The lowered elevations due to mining will increase the capacity to store water on the surface; therefore, the occurrence of downstream flooding should be reduced from the pre-mining condition for all scenarios and areas except for Canal B in Area 1. The volume of flow in Canal B (draining Area 1) will increase throughout the life of the peat mine until all the flow from the 15,000-acre area is routed through the lake to Canal B. The increased flow in the canal will increase the risk of downstream flooding as the storage capacity of the canal is reduced. Canal B will have to be considerably deepened and maintained to ensure rapid removal of water and to lessen the risk of flooding.

For Scenario #2, all areas, annual flow during the 20-year mining period will be less than 30% above the pre-mining flow. With the exception of Area 1, the flows will increase with increased acreage in active mining, then hold relatively constant until the mining area is gradually reclaimed and flows decline. In all areas the flow in year 20 will be significantly reduced from the during mining condition and should be close to or below the pre-mining flow levels as a result of higher evapotranspiration and lower flows from the areas reclaimed to agriculture and forestry. In Area 1 (Scenario #2) annual flows will remain closer to the pre-mining condition because of controlled releases through and evaporation from the lake. Storm peaks will be substantially reduced, assuming no lake or canal over-topping.

Residential areas in Area 4 (Scenario #2) will experience high surface runoff, counterbalancing the flow-reducing effect of the bodies of water created as part of the reclamation plan and resulting in annual flows similar to those of Areas 2 and 3.

Annual flows for Scenario #3 will be the same as Scenario #1 for years 1 through 10. Upon cessation of pumping, canal dams will be broken and all maintenance of canals and dikes will end, creating a swamp/lake area covering all mined and reclaimed areas by year 20. The volume and distribution of runoff from these areas will depend upon the changing nature of the outlets, availability of water storage on the surface of mined areas and the type and density of revegetation. Assuming that the water levels remain high enough to satisfy potential evapotranspiration (PET) at all times, the water available for runoff will be approximately equal to rainfall minus PET.

3.4.7 Nutrient Yields and Surface Water Eutrophication

The peat mining, methanol production and agricultural reclamation in the scenarios may have an adverse impact on water quality. The natural vegetation yields less nitrogen and phosphorus per unit area than other land uses, usually by a large factor; therefore conversion to other uses will result in loss of nutrients to downstream aquatic systems. The lagoons and lakes into which runoff and effluents run or are pumped will probably become unacceptably eutrophic. Unless these lagoons and buffer wetland systems efficiently remove nutrients from the water as it passes through, there will also be substantial nutrient loading of the Pungo and Alligator Rivers and consequent eutrophication.

3.4.8 Trace Element, Pesticide and Coliform Bacteria Yields

Peat mining and subsequent reclamation activities as described in the scenarios are likely to significantly increase trace metals, pesticides and coliform bacteria in runoff from permitted areas. Impacts of such increases presently are not fully known, but, should they occur, are likely to result from the cumulative effects of a variety of trace metals, pesticides, nutrients and other substances.

3.4.9 Groundwater

The alternative scenarios will have a negligible effect on the recharge and yield of the major aquifers and on the fresh/saltwater interface. However, the effects of direct groundwater withdrawals for plant processing and the cumulative effects of direct withdrawals and peat mining are not known. The potential exists for saltwater intrusion into areas where peat is mined close to and below sea level.

3.4.10 Land Use Conversions

The major land use change due to Scenario #2 will be the loss of large tracts of natural, relatively undisturbed wetlands. Approximately 41% (84,000 acres) of the wetlands underlain by peat at least four feet in thickness in the state will be lost under Scenario #2. The mining of 68,000 acres of pocosins (undisturbed and disturbed) in Scenario #2 will constitute a loss of 4.5% of the total remaining pocosins and 7.8% of the undisturbed pocosins in North Carolina. Since the wetland system of the Albemarle-Pamlico Peninsula constitutes the state's largest and least disturbed wetland complex, the elimination of 84,000 acres from this system will be of significance.

Agricultural land will increase from 9.6% to 28.2% of the total acreage in Hyde, Tyrrell and Washington Counties by year 20 under Scenario #2.

3.4.11 Air Quality

Fugitive dust emissions during peat mining, transport and storage will probably be a more serious concern than emissions from methanol plants because of greater particulate emission rates, the occurrence of peat harvesting in all areas (Scenario #2) and the possibility of emissions immediately adjacent to the mining area boundary.

The cumulative impacts of multiple source air pollutants due to expansion of peat mining and processing operations are unknown.

3.4.12 Solid Waste

Leachates from gasification ashes and slags from the methanol plants in the scenarios are not likely to exceed EPA toxicity criteria, due to the relatively low concentrations of most heavy metals in the source peat.

The high temperature and oxidizing environment of the gasification stream is unlikely to produce significant amounts of such substances as tars, oils, phenolics and polynuclear aromatic hydrocarbons which are the hazardous by-products of most concern in many synfuels and gasification facilities.

Large volumes of solid wastes will be generated during conversion of peat to methanol in Scenario #2. Capacity of potential disposal sites on the Albemarle-Pamlico Peninsula to handle this volume is uncertain. Impacts of onsite use of some of this waste during reclamation to agriculture and forestry are not known.

3.4.13 Fire

The frequency of small fires will increase if large-scale peat mining (as described in Scenario #2) occurs, due to increased accessibility of the mined areas to human activity. The larger, less easily controlled fires will decrease in number, since fewer large blocks of open, undisturbed land will remain after mining.

3.4.14 Local Economics and Employment

Peat mining and processing as outlined in the alternative scenarios will lead to increased employment of local workers, migration of new workers and their families into the study area, stimulation of local businesses, demand for new businesses and public services, such as education, and increased employment in the service sector.

Long-run fiscal problems may arise in cases where a local government must provide expanded services and facilities but is unable to tax the new facilities. This is a spillover problem where new residents locate outside the political boundaries of the local governments having the power to tax the facility. Distributional aspects of tax revenues and services required may create deficits in some cities and counties and surpluses in others. Even if long-run benefits exceed costs, short-run fiscal problems may arise where revenues generated lag cost incidence.

To the extent that peat mining adversely affects the commercial fishing and recreation/tourism industries, the value of these economic sectors will decline.

Assuming the smaller peat-to-methanol facility described in Scenario #1 (Area 1) attracts the labor that is available locally, additional employment required for expanded methanol production in Scenario #2 will come primarily from migration. Thus the migrant, new resident and new student impacts will be larger both absolutely and proportionately under Scenario #2 than under Scenario #1, and fiscal effects noted above will be magnified.

While an adequate supply of public services and facilities will probably be available to meet the needs of migrants under Scenario #1, it is unlikely that this would be the case under Scenario #2. More public funds would be required to meet these increased demands for services. This problem will be particularly acute if construction for the methanol production facilities in Scenario #2 is not staged.

The expansion of peat mining activity from the level of Scenario #1 to that of Scenario #2 will attract other related industries and enterprises that will act to magnify the economic impacts of the peat mining itself.

Under Scenario #3, following the failure of the peat mining industry, unemployment will be created proportional to the increase in employment generated by operation of the peat mining and processing facilities. Income will be lost by unemployed mine workers and by workers and businesses serving the basic mining industry. Fixed facilities (housing, businesses and public facilities) will become unused unless other economic activities replace demand lost with the mining facilities.

The extent of the fiscal impacts of Scenario #3 will depend upon the extent to which local government has expanded the services it provides. Excess capacity and high costs of government may result if service construction programs were accelerated. Other services, such as the number of school teachers, could be reduced, but this would lead to higher unemployment and related costs.

Since many services of local government can not be proportionately adjusted downward once provided, and since many are funded by long-term debt, the reduction in tax revenue will be greater than the reduction in costs of government. If this does occur, the costs of operating local government will rise unless offset in some other manner. Property taxes will rise accordingly.

3.5 Summary of Critical Cumulative Environmental and Economic Impacts and Recommended Approaches

3.5.1 Estuarine Impacts

Large-scale conversion of peatlands to agriculture, forestry and peat mining on the Albemarle-Pamlico Peninsula will alter primary nursery areas in peripheral estuarine systems. Changes in salinity regimes; surface water runoff rates; nutrient loading; suspended solids; sedimentation; trace element, pesticide and coliform bacteria levels; and interactions among these factors are believed to be the most significant potential estuarine impacts from land conversion.

The recommended approach includes the initiation of an integrated, multidisciplinary effort toward developing a predictive numerical model for use by decision makers in assessing the impacts of existing and proposed coastal land use on the state's estuarine resources. Such a model could also be used to set effluent limitations to meet water quality standards for primary nursery areas, if such standards were to be established by the state Environmental Management Commission.

3.5.2 Wildlife

A wildlife habitat simulation was used to analyze the consequences of large-scale peat mining on the Albemarle-Pamlico Peninsula. A significant proportion of the currently existing black bear and bobcat habitat will be lost if extensive mining takes place.

Field validation of habitat suitability indices for important species used in the simulation is required. In addition, linking of the spatial and temporal aspects of the wildlife habitat simulation model is necessary to enable land managers to evaluate the impacts of alternative land use decisions on wildlife.

3.5.3 Upland Water Management

Extensive peat mining may increase annual runoff from the mined areas by up to 30% above the pre-mining flow. Annual flows may decrease or increase slightly from the pre-mining flow, depending on the crops, as the mined areas are reclaimed to agriculture and forestry.

Impacts of drainage systems and seasonal pumping on the location of the fresh/saltwater interface in estuarine areas are not known.

The cumulative impacts of groundwater withdrawals for peat processing and drainage from mining sites are not well understood; however, the potential exists for saltwater intrusion into areas where peat is mined close to and below sea level.

Further research is needed in the following areas: hydrology of undisturbed peatlands; nutrient transformation in canal and river networks; field measurement techniques and modeling of surface runoff from actively mined sites; long-term effectiveness of wetland buffers for filtration of nutrients, trace elements and sediments and for control of fresh water flow rate; effectiveness of storage lakes in reducing negative estuarine impacts of land drainage; and effects of peat mining on groundwater supplies and the location of the fresh/salt water interface.

Data from the research recommended above will provide input to an already existing hydrological model, thus aiding in the estimation of the effects of alternative upland water management strategies on surface runoff. The output from this model could provide input to an estuarine model.

3.5.4 Hurricane Flooding

Approximately one-half to two-thirds of the Albemarle-Pamlico Peninsula is subject to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year.

Hurricane tides may push saline water from the sounds up rivers and canals into low lying areas created by peat mining, damaging areas reclaimed to agriculture and forestry. In addition, the effects of hurricane flooding on shallow aquifers under such conditions is not known.

Rains associated with hurricanes may accumulate in low lying areas faster than the capacity of pumps to remove it. Thus the potential also exists for freshwater damage to crop and forest land, depending on the duration of the flooding.

The recommended approach is to develop a new series of maps delineating flood susceptibility based on land elevations that would exist if substantial peat deposits were removed from the region. Sediments underlying the peat deposits should be examined to determine their susceptibility to floodwater infiltration.

3.5.5 Unique Natural Areas

Large-scale peat mining on the peninsula will be accompanied by a loss of part or much of the state's largest and least disturbed wetland complex, and a large proportion of the area underlain by peat of depths greater than four feet. Some of these areas contain prime Atlantic white cedar habitat. Extensive mining will remove a significant proportion of these unique areas and the biota they support.

A systematic attempt should be made to determine if the peninsula contains areas that are unique in biological, hydrological, geological, pedological, chemical or other natural aspects and worthy of consideration for preservation or protection.

3.5.6 Air Quality

The cumulative effects of multiple source air pollutants (from peat harvesting and multiple stacks) from large-scale peat mining and processing on the peninsula are not known and should be monitored and modeled to assess potentially negative impacts.

In addition, refinement of emissions estimates is needed to determine whether fugitive dust emissions during peat mining and transport and storage of peat will have significant negative impacts if extensive mining occurs.

3.5.7 Solid Waste

The capacity of potential disposal sites on the Albemarle-Pamlico Peninsula to handle the volume of non-hazardous waste that would be created by extensive processing of peat is uncertain. Additional research on site selection and evaluation for solid waste disposal is needed.

Impacts of onsite use of some of this waste, for example, on roadbeds or for agricultural land treatment, are not well documented, and may pose environmental problems. Further characterization of the properties of leachates of peat combustion ashes is needed.

3.5.8 Local Economics

Fiscal problems may arise when new residents (migrating to the area to work in peat mining operations) locate outside the political boundaries of local governments having the power to tax peat mining facilites. Distributional aspects of tax revenues and public services required may create deficits in some cities and counties and surpluses in others. Short-term fiscal problems may also arise where generated revenues lag costs.

The development of two simulation models is recommended: 1) a model to address the impact of potential peat mining facilities on tax rates and revenues and 2) a model to examine the overall fiscal impacts of peat mining on state and local government.

3.6 Non-significant Impacts

Elements examined and found to be non-critical included impacts on recreational hunting, agricultural production, forest products (with the exception of Atlantic white cedar) and occurrence of fire.

4. AFFECTED ENVIRONMENT

The environment affected by the alternative peat mining development scenarios (section 5) extends beyond the three counties (Hyde, Tyrrell and Washington) in which development was assumed to occur. This description of the affected environment, therefore, addresses the entire Albemarle-Pamlico Peninsula, including Beaufort and Dare Counties, and the sounds (Albemarle and Pamlico) that bound it on the north, east and south. Groundwater and air resources, which extend beyond the original three county study area, are also discussed.

4.1 Biophysical Environment

4.1.1 General Setting

The Albemarle-Pamlico Peninsula is a low lying, tidewater region bordered by Albemarle Sound to the north, Pamlico Sound and the Pamlico River Estuary to the south, Croatan and Pamlico Sounds to the east and the Suffolk Scarp to the west. Elevations in this area are generally less than 20 feet above mean sea level, and much of the eastern part of the peninsula is less than 5 feet in elevation (Heath, 1975). The area is characterized by poorly integrated coastal streams, deep organic soils, extensive swamps, marshes and evergreen wetlands, and a low astronomical tidal range (Lukin and Mauger, 1983).

The peninsula covers 1,978 square miles (1,266,000 acres) (McMullan, 1984) and includes the largest continuous area of wetlands in North Carolina (Heath, 1975). Counties located on the peninsula include all of Hyde, Tyrrell and Washington Counties, the mainland part of Dare County, and part of Beaufort County.

Approximately 37% of the five counties' total combined land and water area is comprised by lakes, rivers, creeks and sounds. These water bodies, and their intimate intermingling with the land, have shaped the region's geography and its cultural and economic development. The most critical environments in the region occur at the margins between land and water: estuarine marshes, primary nursery areas, shellfish waters and swamp forests.

4.1.2 Hydrology

4.1.2.1 Streams

Only two major streams on the peninsula region have their sources west of the Coastal Plain, originating in the Piedmont. The Roanoke River empties into Albemarle Sound just west of Plymouth. The Tar River, which becomes the Pamlico River at Washington, empties into Pamlico Sound. Other major streams in the areas are the Pungo, Scuppernong and Alligator Rivers. These are short coastal plain streams that become estuaries in their lower reaches. Numerous short, slow flowing coastal tributaries empty into these rivers (Lukin and Mauger, 1983).

Prior to the construction of canals in the area, overland runoff was a major factor in the water budget. Although long-term streamflow data are scarce, overland runoff may be estimated as the difference between precipitation and other water budget items (Heath, 1975):

	Outputs	Inputs
Precipitation		51.0 inches
Evapotranspiration	36.0 inches	
Groundwater discharge	0.5 inches	
Subtotal	36.5 inches	
Overland runoff (estimation by difference)	14.5 inches	

Overflow runoff probably moved north from Lake Phelps to the Scuppernong River and from Lake Mattamuskeet north to the Alligator River prior to construction of an extensive system of canals and ditches (see Figure 4A).

4.1.2.2 Lakes

The peninsula is the site of several lakes: Lake Phelps, on the Washington-Tyrrell County line; Pungo Lake, on the Washington-Hyde County line; and New (Alligator) Lake and Lake Mattamuskeet in Hyde County (see Figure 2A). Lake Mattamuskeet is the largest of these with a surface area of 66.7 square miles (Coastal Zone Resources Corp., 1976). These lakes are very shallow; average depths range from 2.5 to 5 feet. Lake Mattamuskeet and Pungo Lake are now National Wildlife Refuges; Lake Phelps is part of Pettigrew State Park (Lukin and Mauger, 1983).

All four lakes have been modified by drainage systems and the levels of Phelps and Mattamuskeet are regulated. The lakes are isolated from surface inflow and receive water only through rainfall. They accumulate fine organic sediments from dust blown in from the surrounding land and ash from occasional forest and ground fires. No water quality problems in either lake have been reported.

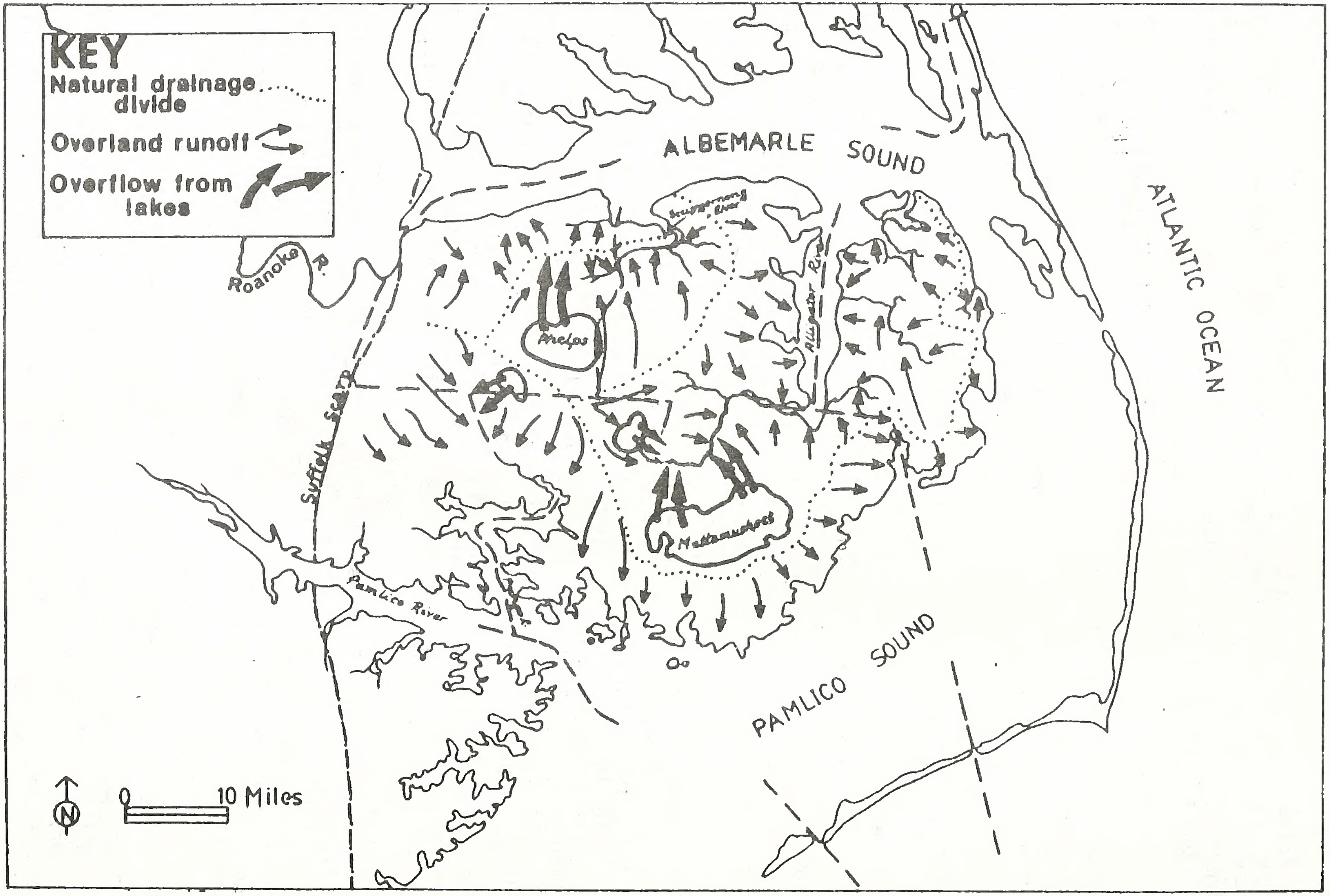

Figure 4A: Drainage divides and probable paths of overland runoff prior to artificial drainage systems (adapted from Heath, 1975)

4.1.2.3 Sounds

4.1.2.3.1 Albemarle Sound

Albemarle Sound covers an area of approximately 480 square miles and contains some 233 billion cubic feet of water. The sound is a drowned river valley estuary with an average depth of less than 18 feet and a maximum depth of 30 feet. The central portion of the sound from Edenton to the Alligator River contains a broad, flat-bottomed trough with depths in excess of 18 feet. Seaward of the Alligator River, the depth of the sound decreases. Textures of bottom sediments grade from predominantly clays in the trough to fine sands along the flanks and the lower portion of the sound (Pels, 1967).

Outflow from Albemarle Sound enters Pamlico Sound through Croatan and Roanoke Sounds, where it discharges into the ocean through Oregon, Hatteras and Ocracoke Inlets. The range of semidiurnal astronomic tides throughout Albemarle Sound is less than 0.5 feet due to the remote connection of the sound to the ocean, combined with freshwater outflow. The periodic tide range is somewhat greater in estuarine tributaries due to funneling effects of decreasing dimensions in an upstream direction (Lukin and Mauger, 1983).

Short-term, wind-driven currents dominate flow and water levels in Albemarle Sound and the adjoining open water areas of Croatan and Roanoke Sounds. The seasonal range of water levels induced by wind-driven currents on Albemarle Sound is about 0.8 feet near Edenton at the mouth of the Chowan River (Daniel, 1977). Wind-induced current velocities ranging from 0.5 knots to 1.6 knots in Croatan and Roanoke Sounds have been measured (Singer and Knowles, 1975, cited by Lukin and Mauger, 1983).

Net flow into Albemarle Sound is dominated by freshwater inflow because the effects of winds blowing from various directions tend to cancel each other out over time. Average inflow to Albemarle Sound is about 17,000 cubic feet per second, draining from a total area of about 18,359 square miles. The peninsula accounts for only 4% of the drainage basin. The average period required for water stored in Albemarle Sound to be completely flushed and replaced by fresh water is about five months (calculated from hydrologic data in Giese et al., 1979, by Lukin and Mauger, 1983).

Periods of high freshwater inflow to Albemarle Sound usually reflect the typical peak flow period of many North Carolina streams, with maximum average freshwater inflow in February and minimum freshwater inflow in October (Lukin and Mauger, 1983).

Average surface salinities are lowest in March following high freshwater inflow from January through March. Surface salinities reach a maximum in December following low freshwater inflow and high evaporation from June through September (Lukin and Mauger, 1983).

Various water quality problems have occurred in the Albemarle Sound system. Severe eutrophication has occurred in the Chowan River, which empties into the sound. Red sore disease has occurred periodically throughout Albemarle Sound. Early signs of general eutrophication are occasionally detected in the western portion of the sound; such signs include elevated phytoplankton cell counts and species ratios, water discoloration and elevated nutrient levels.

4.1.2.3.2 Pamlico Sound

Pamlico Sound covers an area of approximately 2,060 square miles and contains 920 billion cubic feet of water. It is the largest sound formed behind a barrier island strand on the Atlantic coast of the United States (Giese et al., 1979, cited by Lukin and Mauger, 1983). The sound has an average depth of 16 feet and contains a "y"-shaped basin with maximum depths of 26 feet at the confluence of the Neuse and Pamlico Rivers. A broader basin with a maximum depth of 24 feet occurs in the central portion of the sound. A central lagoon shoal separates the two basins and extends across Pamlico Sound from Ocracoke Inlet to Bluff Point (Lukin and Mauger, 1983).

Pamlico Sound is connected with the ocean through Oregon, Hatteras and Ocracoke Inlets. This limited access, combined with the broad expanse of the sound, results in astronomical or ocean tides being significantly dampened. The mean periodic tide range within Pamlico Sound is approximately 0.2 feet. Periodic tide range is considerably greater in the narrow river-estuaries tributary to Pamlico Sound, due to the funneling effect of decreasing dimensions in the upstream direction (Roelofs and Bumpus, 1953 and Giese et al., 1979, cited by Lukin and Mauger, 1983). For example, the mean periodic tide range at the mouth of the Pamlico River is about 0.5 feet and increases to approximately one foot at Washington. Wind-driven currents dominate flow and water levels in the sound and adjoining estuaries (Giese et al., 1979 and Singer and Knowles, 1975, cited by Lukin and Mauger, 1983). The large surface area of Pamlico Sound encourages wind setup over long fetches (Lukin and Mauger, 1983).

Average annual inflow to Pamlico Sound is about 31,700 cubic feet per second, which drains from a total area of 28,820 square miles, less than 3% of which is on the peninsula. Residence time of water in Pamlico Sound is about 11 months. Maximum average freshwater inflow to Pamlico Sound occurs between January and April, with the highest freshwater inflow in February. Minimum net freshwater inflow does not occur in

September, October and November, as is the case for many North Carolina streams, but in June, when evaporation rates are greatest. Evaporative water loss resulting from the large surface area and relatively low freshwater inflow rates are significant factors in the annual gross water budget (Giese et al., 1979, cited by Lukin and Mauger, 1983).

Surface salinity in Pamlico Sound tracks seasonal variations of freshwater inflow, but short-term, wind-induced currents may obscure seasonal salinity variations (Woods, 1967 and Giese et al., 1979, cited by Lukin and Mauger, 1983). Average surface salinities are lowest in April, following peak freshwater inflow. Surface salinities reach a maximum in December after a period of low freshwater inflow in the fall. Seasonal surface salinity differences of 4 to 6 parts per thousand (ppt) are observed at the mouths of major estuaries, while seasonal salinity fluctuations of 0 to 2 ppt are observed in the vicinity of ocean inlets (Giese et al., 1979, cited by Lukin and Mauger, 1983). Salinities in the sound rarely exceed 15 ppt except near inlets.

Over one-third of the sediment reaching Pamlico Sound is transported by the Neuse and Tar-Pamlico Rivers. Local shoreline erosion is an even larger source of sediment. Erosion rates up to 20 feet per year have been observed (Stephen B. Benton, Office of Coastal Management, NRCD, personal communication).

Like Albemarle Sound, Pamlico Sound shows some signs of incipient eutrophication, particularly in some of the tributary estuaries, which receive a nutrient load that is part natural and part man-induced. Agriculture and phosphate mining introduce significant amounts of nutrients, particularly phosphate, into the system.

4.1.2.4 Groundwater

Sand layers in Quarternary sediments serve as the primary source of water supply in Dare County and are of importance to shallow draw throughout the region, particularly in Hyde County (Nelson, 1964). Sand and limestone layers in the Yorktown Formation of Pliocene age are the principal source of water supply in Hyde and Tyrrell Counties and are important for Washington County as well. The Castle Hayne Formation of Middle Eocene age (Jones and Sholar, 1981) is the primary source of water supply in Washington County and the northwestern part of Hyde County (Nelson, 1964).

Under the peninsula lie the cones of depression caused by two very large groundwater withdrawals: Texasgulf's phosphate mines at Aurora, just south of the peninsula, and Union Camp at Franklin, Virginia. Effects from Texasgulf's withdrawals from the Castle Hayne Aquifer have been detected as changes in the potentiometric surfaces in much of the eastern peninsula. Union Camp withdraws water from the Cretaceous Aquifer. No interaction between these cones of depression has been detected. Clay and silt layers act as aquitards, separating the aquifers. There is no evidence that any portion of the study area serves to recharge either the Castle Hayne or the Yorktown Aquifer (Bill Jeter, Division of Environmental Management, NCRD, personal communication).

4.1.2.5 Artificial Drainage

Drainage projects aimed at lowering the water table and removing surface water in peatlands on the Albemarle-Pamlico Peninsula have been undertaken to enhance agricultural and lumbering operations since the late 1700s. The history of drainage practices on the peninsula has been documented by Heath (1975), Lilly (1981), Richardson (1981, 1983) and McMullan (1984).

Since World War II, development of swamp lands for forestry and agriculture in coastal North Carolina has continued. By the 1960s, paper companies owned most of the coastal swamp land not in public ownership. Clark (1981) has estimated that approximately 100,000 acres of wetlands have been cleared and drained or recleared and redrained on the Albemarle-Pamlico Peninsula within the past 15 years.

Drainage pattern alteration on the peninsula began in the late eighteenth century, and a widespread system of canals, ditches and associated roads had been developed in the area by 1970. Large-scale clearing and ditching of forest and evergreen wetlands by the corporate farm industry since 1973 have resulted in significant additions to this artificial drainage system (Lukin and Mauger, 1983).

Main canals are spaced about one mile apart. The material excavated from these canals is used as roadbed fill. Collector ditches are then dug at right angles to the main canals. Finally, smaller v-shaped field ditches are dug at right angles to the collector ditches at intervals of 150 to 350 feet. In an idealized situation, approximately 16 to 20 miles of field ditches and 3 miles of collector ditches drain each square mile of land (Lukin and Mauger, 1983).

Studies of effects of development on regional hydrology and runoff water quality are few. However, available data suggest that peak runoff rates occur earlier and are three to four times higher on developed than on undeveloped lands. Average water table depths measured by Skaggs et al. (1980) were about 9 inches deeper on developed organic soil than on undeveloped organic soil (Lukin and Mauger, 1983).

In eastern Hyde County the drainage system has apparently allowed saltwater intrusion into agricultural lands, although the area affected is relatively small. The intrusion is related to wind tides and the lack of flow control structures on outfall canals. Storm tides are a more significant source of flooding: in 1954, Hurricane Hazel flooded about half of the study area with saltwater.

The effect of freshwater flow from artificial drainage canals into primary estuarine nursery areas has become an issue of increasing concern in recent years. Freshwater intrusion into primary nursery areas was recognized as the most critical environmental problem in the coastal region by the Governor's Coastal Water Management Task Force (1982).

4.1.3 Fishery Resources

4.1.3.1 Marine Fisheries

Pamlico Sound and its tributaries contain the most important fisheries resource in North Carolina. The sound itself is a major commercial fishing ground, and the primary nursery areas around its fringes are essential to commercially important fish and shellfish species. The same species, with a few exceptions such as the menhaden (Brevoortia tyrannus), bay anchovy (Anchoa mitchilli), and silver perch (Bairdiella chrysura), support both commercial and recreational fisheries in the sound. These include: brown shrimp (Penaeus aztecus), white shrimp (P. setiferus), pink shrimp (P. duorarum), blue crab (Callinectes sapidus), oyster (Crassostrea virginica), spot (Leiostomus xanthurus), croaker (Micropogonias undulatus), red drum (Sciaenops ocellatus), weakfish (Cynoscion regalis), spotted seatrout (Cynoscion nebulosus), bluefish (Pomatomus saltatrix), striped mullet (Mugil cephalus), southern flounder (Paralichthys lethostigma), and summer flounder (Paralichthys dentatus) (Birkhead et al., 1977; Copeland et al., 1983; Hester and Copeland, 1975; and others).

4.1.3.2 Freshwater Fisheries

Freshwater areas on and around the peninsula support smaller commercial and recreational fisheries than does Pamlico Sound, but these fisheries are nevertheless significant. Recreational fishing overshadows commercial fishing for most species, but the white perch and eel fisheries are economically important. Important freshwater species of the region include: white perch (*Morone americana*), catfish (*Ictalurus* spp.), bluegill (*Lepomis macrochirus*), other sunfish (*Lepomis* spp.), largemouth bass (*Micropterus salmoides*), eel (*Anguilla rostrata*), and crappie (*Pomoxis* spp.)

4.1.3.3 Anadromous Fisheries

A variety of important anadromous species characterizes the drainage systems of the study area. The major rivers (Chowan, Roanoke) and large creeks have historically supported large runs of these fish. Some anadromous fishes now spawn in artificial drainage canals. Species present include: blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharangus*), striped bass (*Morone saxatilus*), American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), and Atlantic sturgeon (*Acipenser oxyrhynchus*) (Hassler et al., 1981; Johnson et al., 1977, 1979; Street, 1982; Street et al., 1975).

The striped bass populations in this region, and along the entire Atlantic coast, appear to be declining, possibly in response to water quality problems.

4.1.4 Soils and Farmland

Soils of the area can be divided into two main groups, depending on their location. Those soils east of the Suffolk Scarp are the youngest and most poorly drained. Broad, flat interstream areas have combined with impermeable underlying sediments to create conditions favorable for slow water runoff and eventual accumulation of organic matter. Extensive swamplands occur in this area. Soils west of the Suffolk Scarp tend to be better drained because of higher elevations and have better developed drainage patterns (Governor's Coastal Water Management Task Force, 1982).

Soils are predominantly sandy with firm subsoils, but clayey and silty textured soils are also commonly found. Organic soils (histosols) have formed in swampy areas where organic matter accumulation has occurred. (Governor's Coastal Water Management Task Force, 1982). Deep organic soils cover much of the peninsula. In the three-county study area, over 100,000 acres are covered by organic soils deeper than four feet.

Agricultural statistics indicate that 206,730 acres of cropland were harvested on the peninsula in the 1979-80 season: 83,280 acres in Washington County, 77,100 acres in Hyde County, 45,440 acres in Tyrrell County, and 900 acres in Dare County (Lukin and Mauger, 1983).

4.1.5 Forests

Between 1963 and 1973, commercial forest lands on the northeastern Coastal Plain of North Carolina decreased by more than 3%. More than half of this loss of forested areas was a result of conversion to agricultural land, primarily in those counties south of Albemarle Sound (Lukin and Mauger, 1983).

Forests on the peninsula cover 729,000 acres, about 70% of the total area. Most of the forested areas occur on deep organic soils and fall into six classes in two major groups:

- Upland Forests
  - Deciduous Forest Land: oak, hickory, tulip poplar
  - Evergreen Forest Land: peninsular upland pine forests, broadleaf-evergreen dominated forest, managed pine plantations
  - Mixed Forest Land

Forested Wetlands

Swamp Forest: gum-cypress swamps, mixed hardwood bottomland swamps, Atlantic white cedar swamps, some pine-hardwood swamps, "high brush swamps"

Evergreen Wetland: pond pine and broadleaf evergreens (bays and wax myrtle), pocosins, shrub bogs, bay forests, pond pine forests

Disrupted Grass and/or Shrub Wetland: some pond pines, grouped with forest lands because they were produced by alteration of evergreen forests and will revert to evergreen forests if no further disruptions occur

(Lukin and Mauger, 1983)

4.1.6 Mineral and Energy Resources

4.1.6.1 Phosphate

The most economically valuable mineral resource in the North Carolina coastal region is phosphate, occurring as carbonate fluorapatite in the Pungo River Formation of Middle Miocene age. This formation underlies much of the outer Coastal Plain north of the Neuse River. Phosphate is mined in central Beaufort County, on the south shore of the Pamlico River. It is not mined on the Albemarle-Pamlico Peninsula because of the depths at which the phosphate deposits lie in the subsurface.

4.1.6.2 Oil and Gas

Oil and gas have been sought in 42 exploratory wells on the peninsula in the past 37 years, but none has been found. Oil and gas activity on the outer continental shelf 50 miles east of the peninsula may eventually lead to pipeline construction, but no such activity is currently planned.

4.1.6.3 Peat

The only potentially valuable energy resource in the coastal region is a generally fine grained, highly decomposed black peat (Ingram and Otte 1981, 1982). Extensive peat deposits occur in North Carolina, the largest of which are located on the Albemarle- Pamlico Peninsula. The peninsula contains approximately 278 million dry tons of peat over an area of about 582 square miles (373,000 acres). The peat deposits occur in shallow depressions to a depth of 10 feet and in narrow former stream channels to a depth of 16 feet (Ingram and Otte, 1982).

Peat deposits are associated primarily with the Alligator River drainage system. Thick peat occurs along both shores. Peat-filled tributaries extend eastward into Dare County, southward into Hyde County and westward into Tyrrell County, where the peats of the Southwest Fork of the river are very extensive, spreading west and south in the vicinity of Lake Phelps (see Figure 4B).

The peat is generally sapric and moderately to highly decomposed. Ash content is generally low (6-10 percent average), as is sulfur (less than 0.5%). Stumps and logs occur frequently, especially in the thicker peat deposits (Ingram and Otte, 1982).

The peats of the peninsula yield approximately 10,000 Btu's per pound (moisture free) and could provide almost 6 quadrillion Btu's of energy value if mined completely and used efficiently. This amount could meet the state's thermal needs for almost 4 years at 1980 consumption levels (calculated from Ingram and Otte, 1982 and Harwood and McMullan, 1981, by Lukin and Mauger, 1983).

4.1.7 Wildlife

The Albemarle-Pamlico Peninsula contains rich and abundant wildlife resources as a result of the high quality and diversity of available habitat. The broad floodplains of the Roanoke, Pamlico-Tar and Alligator Rivers transecting the area, the vast estuarine marshes and the low flatlands that were historically the floor of the Atlantic Ocean create a mixture of ecological systems unsurpassed in richness, diversity and complexity anywhere in the state.

4.1.8 Parks, Refuges and Natural Areas

Major portions of the peninsula are publicly owned and managed (Figure 4C). There are national wildlife refuges at Pungo Lake, Lake Mattamuskeet, and Swanquarter. In March, 1984, 120,000 acres of land in Dare and Tyrrell Counties were donated to the federal government to create the Alligator River National Wildlife Refuge. Lake Phelps is a state park. Gull Rock State Gameland is managed to conserve wetlands and bear habitat. The Air Force Bombing Range in Dare County, while not a refuge, is managed to conserve natural habitat and is closed to hunting. A large portion (27,000 acres) of the bombing range is pending entry in the N. C. Natural Heritage Registry and will be managed by the Air Force to preserve large examples of three types of pocosin communities.

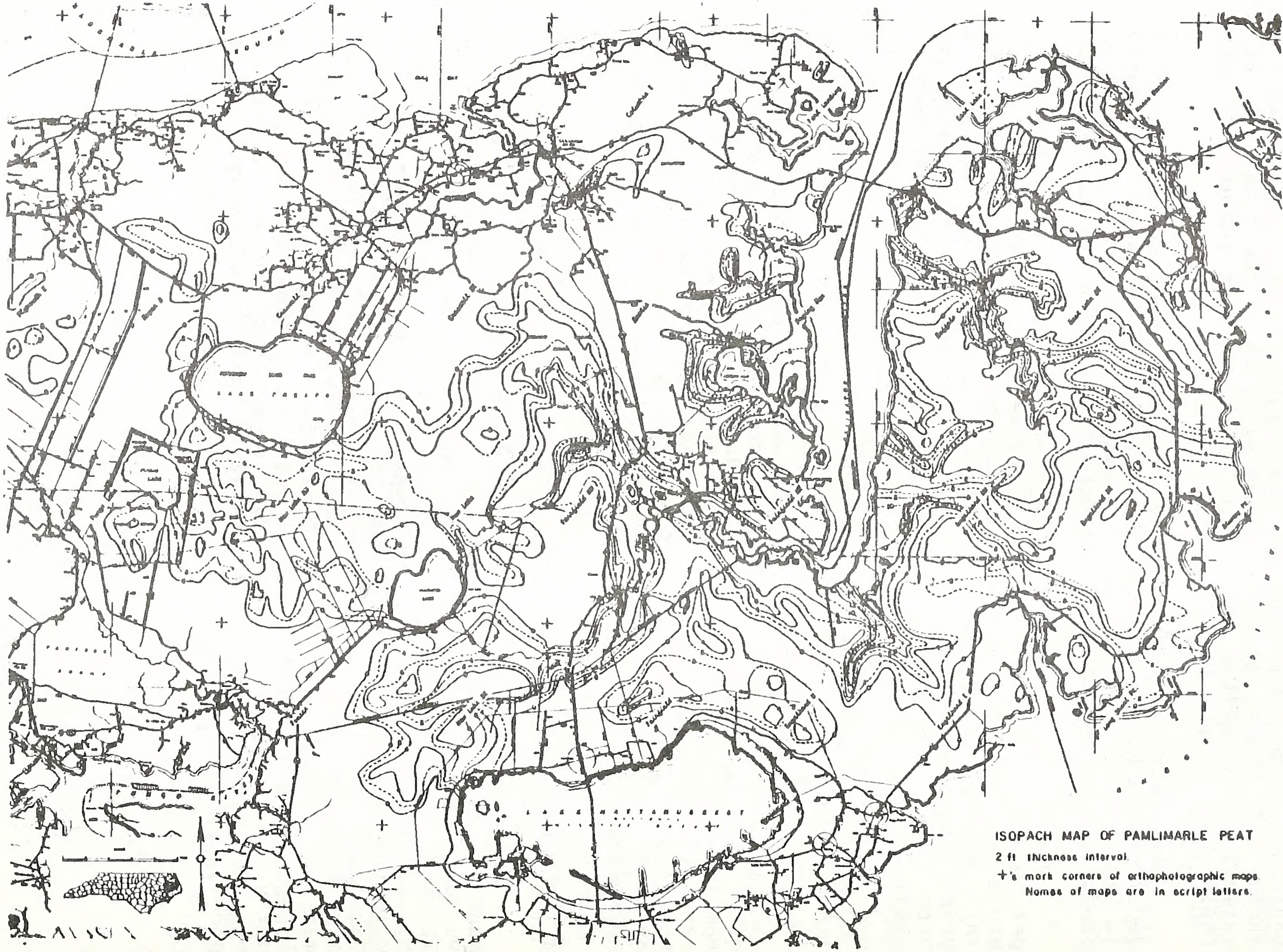
ISOPACH MAP OF PAMLIMARLE PEAT
2 ft thickness interval
+'s mark corners of orthophotographic maps.
Names of maps are in script letters.
LAKE PHELPS
LAKE MATTAMUSKEET

Figure 4B: Isopach map of peat on the Albemarle-Pamlico Peninsula (from Ingram and Otte, 1982)

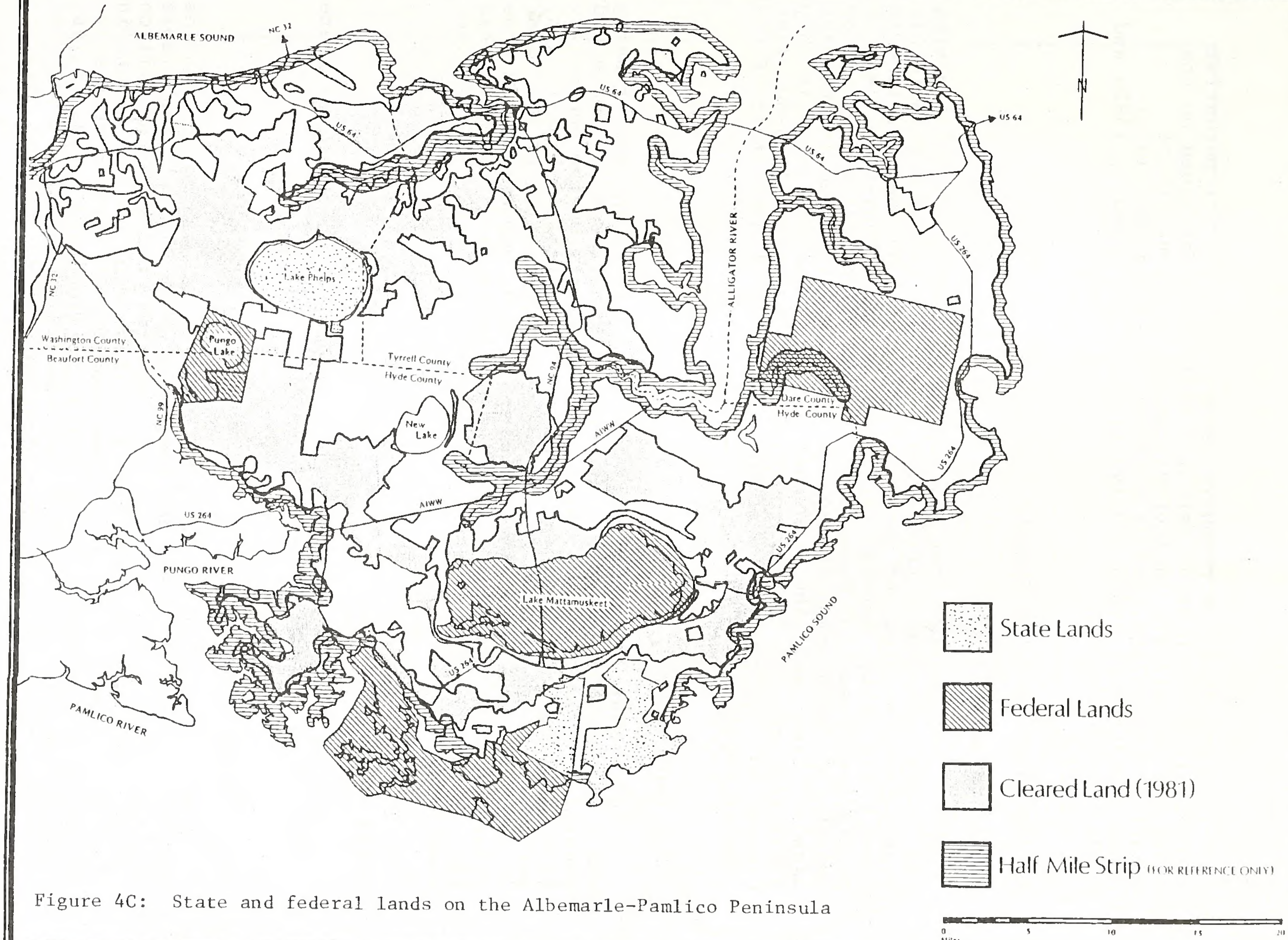

Figure 4C: State and federal lands on the Albemarle-Pamlico Peninsula

The peninsula has recently been inventoried for potential natural areas. Such areas were identified and described on the basis of: 1) relative lack of disturbance, 2) quality of botanical assemblage, and 3) size (McDonald and Ash, 1981; Peacock and Lynch, 1982a and 1982b; Lynch and Peacock, 1982a and 1982b).

4.2 Socioeconomic Environment

4.2.1 Population

The region is sparsely populated, with a few small cities and towns. In the three-county study area the population is aggregated in areas of good farmland and along the shoreline in towns originally settled as fishing ports. A long-term trend of population loss in Hyde and Tyrrell Counties and very slow growth in Washington County was apparently reversed in the past decade. Even so, the regional growth rate of +5.1% is only one-third of the state growth rate of +15.5% for 1970-80. (See Figure 4D for comparison of these counties with the rest of the coastal region.)

4.2.2 Employment

Agriculture, forestry commercial fishing and shellfishing and recreational industries have traditionally dominated economic activity, and therefore employment, on the peninsula. Although such employment remains economically significant, particularly in terms of income, the composition of the labor force in the area is shifting toward employment in the industrial and service sectors (see Table 4A). This shift has been coupled with increased commuting to work in adjacent counties.

4.2.3 Income

Median family and personal income fall below the state medians in all three counties (Tables 4B and 4C).

4.2.4 Economic Sectors

Commercial fishing in Hyde, Tyrrell and Washington Counties in 1980 produced fish and shellfish worth $4.5 million (Table 4D) and $49.4 million in the counties bordering on Pamlico Sound. (Not all seafood landed in these counties was caught in Pamlico Sound.) In the three counties, this compares to agricultural products worth $42.3 million and estimated 1982 forestry output worth $3.9 million (Alex Dowdell, Div. Forest Resources, NRCD, personal communication).

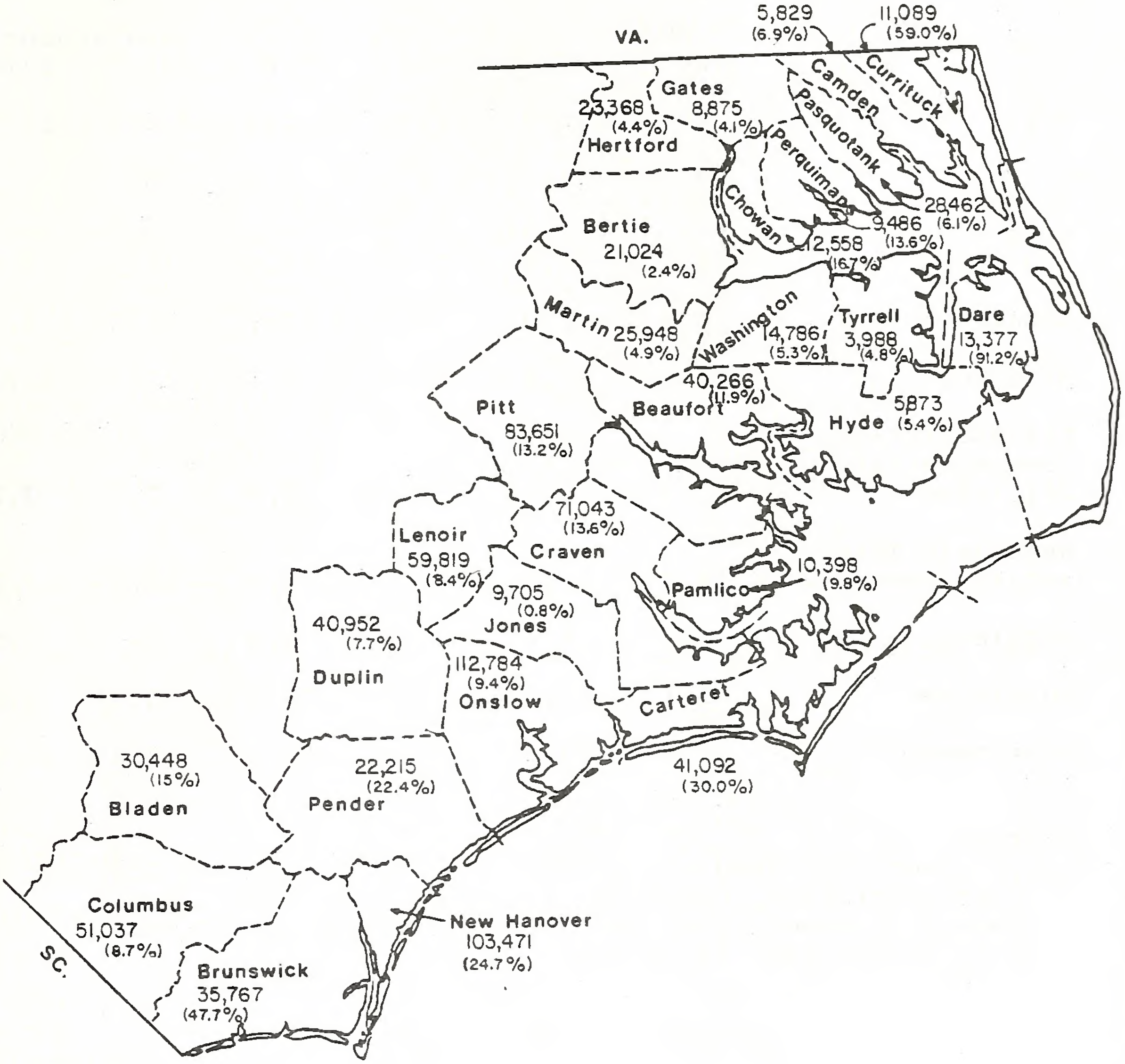

Figure 4D: Total population, 1980, and percentage change in total population, 1970-1980

Table 4A: Employment summary by industry groups by county, 1960, 1970

	Hyde		Tyrrell		Washington	
	1960	1970	1960	1970	1960	1970
Total Employed	1,686	1,699	1,354	1,220	4,088	4,679
	%	%	%	%	%	%
Agriculture/ Forestry/ Fisheries	44.7	26.0	27.7	18.4	16.9	9.8
Construction	5.3	10.0	6.7	11.7	3.8	5.9
Manufacturing	10.3	17.4	20.0	19.9	17.2	42.4
Transportation/ Communication/ Utilities	3.3	4.5	3.1	1.9	2.2	2.2
Wholesale Trade/ Retail Trade	13.0	13.5	16.5	16.7	15.8	13.9
Services	-	6.8	-	8.0	-	8.5
Education	5.1	10.1	7.0	10.3	3.1	5.8
Government	4.4	25.1	2.0	18.4	3.4	13.0

Source:
U.S. Census of Population, 1960 General Social and Economic Characteristics, North Carolina Table 85, 1960. U.S. Census of Population, 1970, General Social and Economic Characteristics, Table 123.

Table 4B: Median family income by county, 1960,1970

	1960		1970	
	Median Family Income	Families Below Poverty Line (%)	Median Family Income	Families Below Poverty Line (%)
Hyde	$1,979	N.A.	$4,430	33.5
Tyrrell	1,927	N.A.	4,307	37.9
Washington	3,495	N.A.	7,152	23.7
North Carolina	$3,956	N.A.	$7,770	16.5

Note:
N.A.=not available
Source:
Local Area Personal Income, South East Region, U.S. Department of Commerce, Bureau of Economic Analysis

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Table 4C: Per capita personal income by county, 1970, 1975, 1977

	Per Capita Personal Income		
	1970	1975	1977
Hyde	$2,204	$3,612	$3,901
Tyrrell	2,046	3,589	4,358
Washington	2,710	4,096	4,946
North Carolina	$3,200	$4,940	$5,916

Source:
Local Area Personal Income, South East Region, U.S. Department of Commerce, Bureau of Economic Analysis.

Table 4D: Commercial fishing vessel licenses, pounds landed and dockside value by county 1975-1980*

	Pounds			Dockside Value ($)			Commercial Vessel Licenses		
	1975 (000s)	1980 (000s)	Change %	1975 (000s)	1980 (000s)	Change %	1975 (000s)	1980 (000s)	Change %
Hyde	3,204	13,056	307.5	770	4,182	443.1	448	415	-7.4
Tyrrell	766	976	27.4	143	228	59.4	143	113	-21.0
Washington	604	532	-11.9	88	100	13.6	254	263	3.5
NC	72,326	153,805	112.7	16,409	61,390	274.1	17,776	18,268	2.8

* The figures do not include menhaden landings

Source:
Division of Marine Fisheries, NRCD, "Annual Statistics on Fish Landings"

There is little current manufacturing in the three counties: two small garment operations and numerous small agricultural processors and supplies. Large industrial paper and textile operations are located in Beaufort and Martin Counties adjacent to the study area. There is no large scale chemical or electrical facility in the region or any of the adjacent counties.

4.2.5 Transportation Infrastructure

Highway access on the peninsula is generally good east-west and limited north-south. The north-south highways (NC 32, 45, 94 and 99) are utilized primarily by local traffic and are not heavily traveled (Cribbins, 1983).

Water access is very good: the peninsula is bisected by the Intracoastal Waterway and surrounded on three sides by water. Barge terminals of varying quality exist in Belhaven, Columbia, Edenton and Plymouth. Lack of shoreside loading equipment, limited depth of approach channel or turning basin and inadequate storage area are characteristic of some of these facilities (Cribbins, 1983).

Rail access is available only at the western end of the peninsula. Dare, Hyde and Tyrrell Counties have no rail service (Cribbins, 1983).

No petroleum product pipelines exist in the region and natural gas service is not available in Dare and Tyrrell Counties (Cribbins, 1983).

4.3 Legal-institutional Environment

This section reviews the governmental setting in which the proposed peat mining will take place, the major regulatory controls available to mitigate any adverse environmental consequences of mining and possible responses of the affected local governments.

4.3.1 Local and County Government

Washington and Hyde Counties have commission-manager governments. Tyrrell County is run directly by a board of commissioners; the chief executive officer is the county finance officer. Washington and Hyde maintain planning officers. All three counties participate in land use planning through the state Coastal Area Management Act (CAMA). Each county has a single unified school district.

The only incorporated towns on the peninsula are Plymouth, Creswell, Roper and Columbia. Each has a mayor-council government. Plymouth has its own planning department. Plymouth, Roper and Creswell have zoning ordinances; the counties and Columbia do not. There are no special taxation districts on the peninsula.

In Washington County the county acts as a drainage district to carry out drainage projects, but is organized under Article 3, Chapter 139 of the General Statutes of North Carolina, not under Chapter 156, which governs drainage districts. Hyde County contains Fairfield and Grassy Ridge drainage districts, both of which have been active since 1976. In Tyrrell County the only active drainage district is Gum Neck.

4.3.2 Major Regulatory Controls

4.3.2.1 State Regulatory Controls

Some exclusively state permits and some federal permits administered by the state are applicable to peat mining. This section discusses the former. Federal-state permits are addressed in section 4.3.2.2.

4.3.2.1.1 Mining Act

The major state regulatory tool for the control of the environmental impacts of peat mining is the Mining Act of 1971 (G. S. 74-46 et seq.). This law requires a permit before surface mining is undertaken, and in order to obtain a permit the applicant must demonstrate that the mining will not violate air and water quality standards, will not result in substantial deposits of sediment in stream beds or lakes, or landslides, and will not have unduly adverse effects on fish and wildlife. A reclamation plan is required; a bond must be kept in effect until reclamation is complete. The maximum amount of the bond ($50,000) is set according to a schedule established by the Mining Commission. This is an extremely small per acre amount if the state must undertake substantial reclamation efforts or must support pumping or maintenance of drainage systems. Since the maximum amount of reclamation bonds is no longer set by statute, the Mining Commission has authority to increase the amount of the bonds to make them more adequate on a per acre basis.

Reclamation plans for some of the potentially minable areas may require that water be perpetually pumped from the reclaimed land in order for the land to support farming or timbering activities. A possible legal technique for enforcing this requirement is through the mining permit and bond requirements. The Mining Act provisions (G.S. 74-46 through G.S. 74-68), when read as a whole, appear to comtemplate that reclamation will be completed within a reasonable time after the conclusion of mining activities, and that when reclamation has been completed in a satisfactory manner the bond will be released and no further undertakings will be required of the holder of the mining permit. That is, the Act appears to contemplate that reclamation activities will have a definite termination date. Although G.S. 74-53 requires reclamation to be completed within two years of the termination of mining, it authorizes the Department of Natural Resources and Community Development (NRCD) to allow a longer time. If NRCD may allow a longer time, it is arguable that when circumstances so require, NRCD may require a longer time. This is supported by G.S. 74-49(12), which defines "reclamation" as being the "reasonable rehabilitation of the affected land for useful purposes". G.S. 74-54 provides that the liability under the bond must be maintained until reclamation is completed in accordance with the plan; thus it would appear that all or a portion of the bond could be continued in effect to indemnify the state in the event it should have to continue the pumping after failure or refusal of the permit holder to do so.

4.3.2.1.2 Capacity Use Designation

All of Washington County and portions of Hyde and Tyrrell Counties have been designated capacity use areas pursuant to the Water Use Act of 1967 (G. S. 143-215.11 et seq.), and the remaining portions of the counties could be so designated pursuant to this law. Within the designated areas, a permit from the Environmental Management Commission is required for withdrawal or utilization of water in excess of 100,000 gallons per day. The Commission must also approve "any project involving the excavation of any single area in excess of five acres to a depth below the highest natural level of groundwater" (15 N.C.A.C. 2E .0205).

4.3.2.1.3 Areas of Environmental Concern (Coastal Area Management Act)

The North Carolina Coastal Area Management Act (CAMA), in listing potential areas of environmental concern, adopts as its definition of "wetlands" in G.S. 113A-113(b)(1) the same definition used in G.S. 113-230(a). G.S. 113-230(a) (part of the dredge and fill permit law) adopts for its definition of "coastal wetlands" any marsh as defined by G.S. 113-229(n)(3), plus certain contiguous land. G.S. 113-229(n)(3), in turn, defines "marshland" as any marsh subject to tidal flooding in which is found at least one of ten named species of plants. Thus a "wetland" as defined under CAMA is "any marsh subject to tidal flooding in which is found at least one of ten named species of plants".

Should any mining activity take place within an Area of Environmental Concern designated pursuant to the Coastal Area Management Act (G. S. 113-100 et seq.), a major development permit would be required from the Coastal Resources Commission.

4.3.2.2 Federal Regulatory Controls

4.3.2.2.1 NPDES Permits

Any water discharges from canals draining mining sites or other point sources require an NPDES Permit, administered by the state, but mandated by the federal Clean Water Act (33 U.S.C. Section 1251 et seq.). Water quality standards must be met for the permit to be obtained. Also, under Section 401 of the Clean Water Act, the state must certify to EPA that no effluent standard, water quality limit or toxic pollutant standard will be violated by the mining activity.

4.3.2.2.2 Clean Air Act

The air quality in the study area counties meets or exceeds that required by the national air quality standards, and, therefore, the area is designated a Prevention of Significant Deterioration (PSD) area. The state, through its state implementation plan, administers and enforces the federal Clean Air Act (42 U.S.C. section 7401 et seq.) and by means of that plan must enforce the standards for PSD areas. These standards, in summary, require that the air quality in PSD areas not exceed certain stated increments for listed pollutants, including particulate matter. The area is a class II PSD area, to which moderately stringent standards are applied, except for the Swan Quarter National Wildlife Refuge in Hyde County, which is a class I area, to which the most stringent standards are applied. Activities occurring outside a class I area must not cause a violation of the class I standards within the area. Mining activities would be regulated under the PSD planning and permitting provisions if the activity emits or has the capacity to emit 250 tons per year, or more, of a controlled pollutant, such as particulates (40 C.F.R. section 52.21 et seq.). The most likely control measures that would be applied are work practice standards designed to control fugitive emissions.

4.3.2.2.3 404 Dredge and Fill Permits

If dredged or fill material is to be deposited into navigable waters or associated wetlands as part of the mining activity, a permit must be obtained from the U. S. Army Corps of Engineers under Section 404 of the Clean Water Act (33 U.S.C. Section 1344). The conditions of this permit must be such that fishery areas and wildlife are not adversely affected. No permit is required for normal farming and forestry operations such as plowing, seeding, cultivation and minor drainage or "for the purpose of construction or maintenance of farm roads or forest roads, or temporary roads for moving mining equipment, where such roads are constructed and maintained, in accordance with best management practices" to assure that the flow and quality of the water is unimpaired (33 U.S.C. section 1344(f)).

For purposes of issuing dredge and fill permits in the naviagable waters of the United States pursuant to Section 404, the Army Corps Engineers and EPA have adopted the same definition of "wetlands." For the Corps of Engineers, the definition appears at 33 C.F.R. section 323.2(c); for EPA, at 40 C.F.R. section 230.3(t). The definition is: "The term 'wetlands' means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

If a Section 404 permit is required, the Corps of Engineers must also prepare an environmental impact statement under the National Environmental Policy Act (42 U.S.C. section 4321 et seq.).

4.3.2.2.4 Endangered Species Act

The study area provides habitat for at least three animals that have been listed as endangered species: the redcockaded woodpecker, the bald eagle and the American alligator; another endangered species, the eastern cougar, may inhabit the area (50 C.F.R. section 17.11). No critical habitats have been designated for these species, but the cougar and woodpecker are listed as endangered throughout their ranges and the eagle is endangered in the lower 48 states. The case of Palila v. Department of Land and Natural Resources, 471 F. Supp. 985 (D. Haw. 1979), aff'd 639 F.2d 495 (9th Cir. 1981), held that state action allowing the deterioration of the habitat of an endangered species is a "taking" within the meaning of the Endangered Species Act (16 U.S.C. section 1531 et seq.) and may be enjoined by a federal court. In that case, the habitat destruction was taking place in an area designated as critical habitat for the palila, an endangered Hawaiian bird, by the U.S. Fish and Wildlife Service, and, therefore, the case against the state was strong. Private organizations might also rely on the Endangered Species Act to block mining activities that are disruptive to critical habitat.

4.3.3 County Responses

A county may respond to large-scale mining activities by requiring a local environmental impact statement; adopting a land use ordinance requiring a county mining permit; and/or pressing for state enabling legislation that would authorize the levy of a severance tax (Brower et al., 1983).

4.3.3.1 Local Environmental Impact Statement

Local governments are authorized by G.S. 113A-8 to require environmental impact statements for major development projects, which are defined to include commercial and industrial projects of more than two contiguous acres. A peat mine would appear to fit this definition. An environmental impact statement might be quite helpful to a county in making plans for dealing with the social, economic and environmental impacts of large-scale mining, but the statement is informational only and does not empower the county to veto the project because the predicted environmental consequences are severe, nor does it bind the mine operator to any particular environmental standards. For the requirement of a county environmental impact statement to be effective, the county must employ a person capable of drafting and administering the impact statement ordinance and reviewing the completed statement for adequacy.

4.3.3.2 County Mining Permit

Counties may respond to mining activities that are regulated by the state under the Mining Act by enacting land use regulations. County zoning regulations might be honored to some extent, but a county prohibition of mining would -- in the face of a state permit -- clearly be preempted by state law. Brower et al. (1983) indicate that the county would require a reclamation bond in addition to the state bond. However, the strong possibility of preemption exists here also. Although some effective land use regulation might be adopted at the county level to deal with mining, it would have to be very carefully tailored to avoid state preemption, and even then it would probably invite litigation by the mining companies.

4.3.3.3 Severance Tax

Peat mining itself will not generate additional property taxes in affected counties, although counties in which peat processing plants are located will receive some property taxes. Therefore, for the counties to realize any significant amount of tax revenues from the mining operations, a severance tax would be required. For a number of reasons outlined by Brower et al. (1983), the ad valorem property tax on peat deposits is, as a practical matter, worth nothing. The primary reason for this is the great difficulty in appraising the deposits.

Severance taxes can take a number of forms, including a per unit tax on each ton or other quantity of the product mined, or a percentage of the sales price of the resource mined. A portion of the tax could be allocated for reclamation efforts. Other states with severance taxes could provide models for a North Carolina tax. State legislation would be required before counties could levy any sort of a severance tax. The tax could also be made a state tax.

5. ALTERNATIVE PEAT MINING DEVELOPMENT SCENARIOS

5.1 Introductory Section

In the context of this project, a scenario is a set of assumptions about the course of peat mining development over a 20-year period. In Scenario #1 (currently permitted acreage mined as proposed), these assumptions are based as much as possible on the stated plans of peat mining companies that held mining permits or had applied for permits as of summer, 1983. Where plans for specific aspects of the scenarios were not available, attempts were made to make the most "reasonable" assumptions possible. Comments on early drafts of the scenarios by representatives of the peat mining industry and by state agency personnel involved with permitting processes contributed to the refinement of these assumptions.

Scenarios #2 and #3 are based entirely on assumption and (except for the section of Scenario #3 between years 1 and 10 which corresponds to Scenario #1) do not represent the stated plans of any peat mining industry or landowner in the study area.

In all scenarios, national economic conditions are assumed to warrant the development described.

Two mining areas have been delineated for Scenarios #1 and #3 based on permits issued and permit applications submitted as of summer, 1983, geographical location, and drainage characteristics. These areas are shown in Figure 5B.

Four mining areas are outlined for Scenario #2 based on drainage characteristics and geographical location (see Figure 5G). Areas 1 and 2 of this scenario are expansions of Areas 1 and 2 in Scenario #1. Areas 3 and 4 of Scenario #2 are areas for which no mining permit applications have been submitted to date, but in which substantial peat deposits lie.

The following pages outline each of the three scenarios, stating assumptions made about each of the following aspects:

1) Permitted acreage
2) Land disturbance
3) Mining and processing technologies
4) Transportation
5) Water management
6) Air quality management
7) Solid waste management
8) Wildlife mitigation measures
9) Fire protection measures
10) Reclamation plans

5.2 Alternatives

5.2.1 No Change

This alternative assumes that neither peat mining nor any other type of development occurs during the 20-year study period in areas within the boundaries of the scenarios. No further ditching occurs and the permit areas remain largely in their present state. Agricultural and forestry operations currently underway continue but do not expand; no conversions from one land use-habitat type to another, other than normal succession, occur.

Burned and otherwise disturbed acreage not under cultivation or in pine plantations in the permitted areas undergo natural vegetational succession and eventually revert to low or high pocosin.

5.2.2 Scenario #1: Currently Permitted Acreage

(Static: at years 1/10/20 and/or Cumulative: years 1-10 and 11-20)

Note: Peat Methanol Associates (PMA) documents refer only to 15,012 acres assumed permitted for methanol production in Area 1 and do not refer to horticultural peat operations.

5.2.2.1 Permitted Mining Activity

5.2.2.1.1 Permitted Acreage

	year 1	10	20
Area 1	15,818		
Area 2	7,142		
Total	22,960		

Assumptions:
No further acreage is permitted during the next 20 years
Permit renewals are granted for continuation of mining on already permitted acreage
First Colony Farms' mining permit is transferred to PMA

Sources:
Mining Permits
Figure 5A

5.2.2.1.2 Location of Permitted Acreage

see Figure 5B

Figure 5A: Scenario #1-- Acreage disturbed

	Year				
	1 2 3 4 5	6 7 8 9 10	11 12 13 14 15	16 17 18 19 20	Total
Area 1 Permitted: 15,818 ac. Mined: 11,360 ac.	3,080	2,440	3,400	2,440	11,360 ac.
Area 2 Permitted: 7,142 ac. Mined: 6,000 ac.	1,500	1,500	1,500	1,500	6,000 ac.
Maximum Acreage Disturbed	8,520		8,840		17,360 ac.

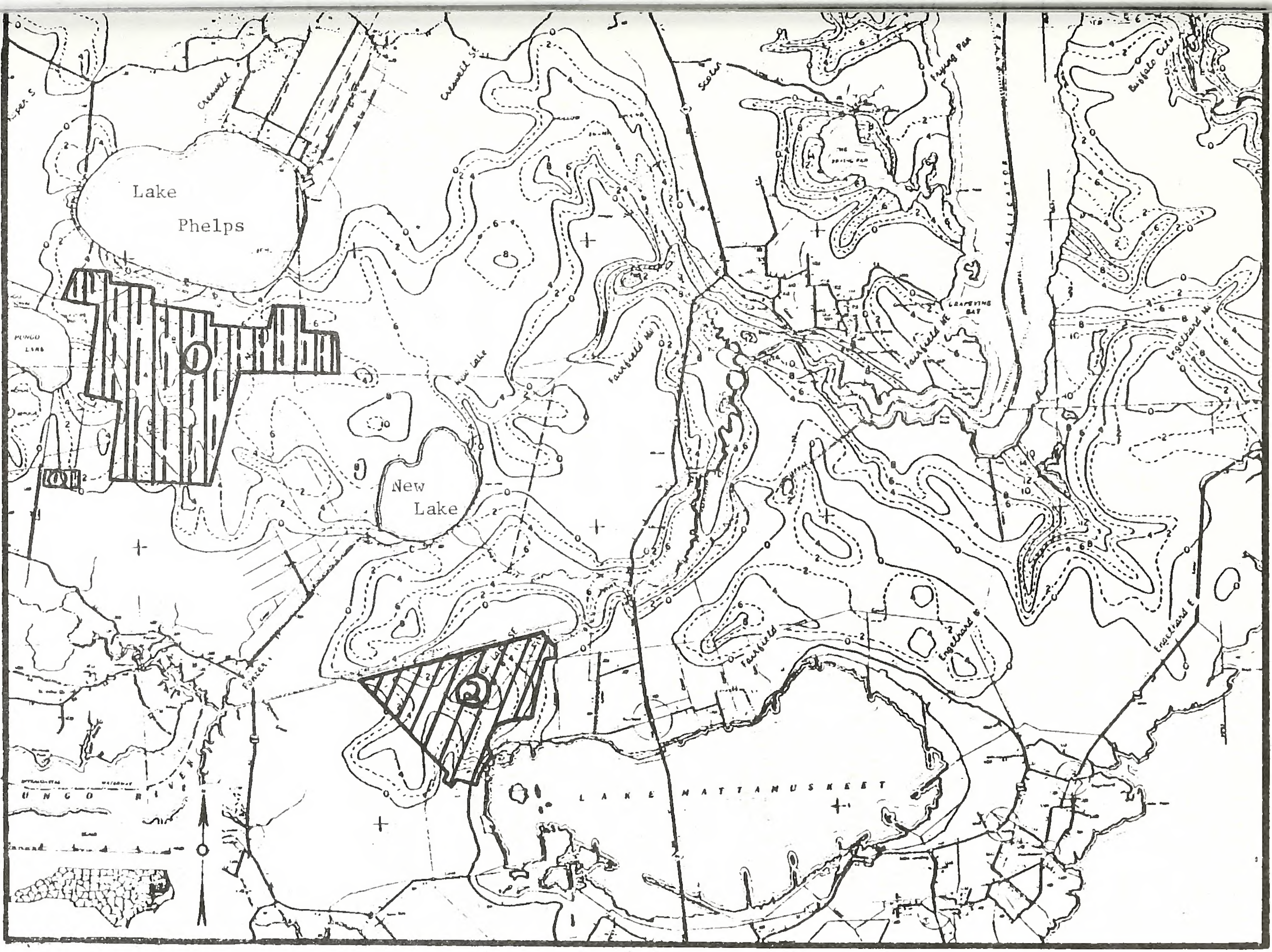


Figure 5B: Scenario #1-- Currently Permitted Acreage

(Basemap - Isopach Map of Pamlimarle Peat - 2 ft thickness interval - from Ingram and Otte. 1982)

Key: Area 1 ▥ 15,818 acres
Area 2 ▨ 7,142 acres

5.2.2.2 Land Disturbance

5.2.2.2.1 Acreage Mined (cumulative)

	by 10	by 20
Area 1	5,520	11,360
Area 2	3,000	6,000
Total	8,520	17,360

Assumptions:
Mining start dates and rates occur as indicated in Figure 5A
Disturbed acreages for Area 2 and for the horticultural operations in Area 1
Sources:
PMA, 1983d, Fig. 2-10 (blocks fully or partially mined or in preparation at years 5, 10, 15 and 20)
Figure 5A

5.2.2.2.2 Average Acreage in Peat Mining Production at Any One Time

	1-10	11-20
Area 1	2,000	2,000
Area 2	1,500	1,500
Total	3,500	3,500

Assumption:
Average acreage in production for Area 2
Source:
PMA, 1983c, d

5.2.2.2.3 Maximum Acreage Disturbed (in Preparation or Being Mined) at Any One Time

	at 10	at 20
Area 1	2,880	2,560
Area 2	1,800	1,800
Total	4,680	4,360

Assumption:
Maximum acreage disturbed for Area 2
Source:
PMA, 1983c,d

5.2.2.2.4 Average Annual Rate of Land Disturbance

	1-10	11-20
Area 1	552	584
Area 2	300	300

Assumptions:
Mining rates

5.2.2.2.5 Elevation of Mined Acreage

	Land Elev. (MSL)	Expected Max. Mine Depth	Average Depth of Mining	Elev of Mined Acreage (MSL)
Area 1	13-18'	9'	4-5'	7-12'
Area 2	5-10'	9'	4-5'	1'

Sources:
Elevations - see Figure 5C
Mining Permit Applications
WTF Mining Permit
PMA, 1983c

5.2.2.2.6 Undisturbed Permitted Acreage at Year 20

Area 1	4,458
Area 2	1,142 (includes a 410 acre conservation easement-to remain unmined)
Total	5,600

Assumptions:
Mining of Area 1 acreage is expected to occur over a period of 34 years
Mining of Area 2 permitted acreage is expected to occur over a period of more than 20 years

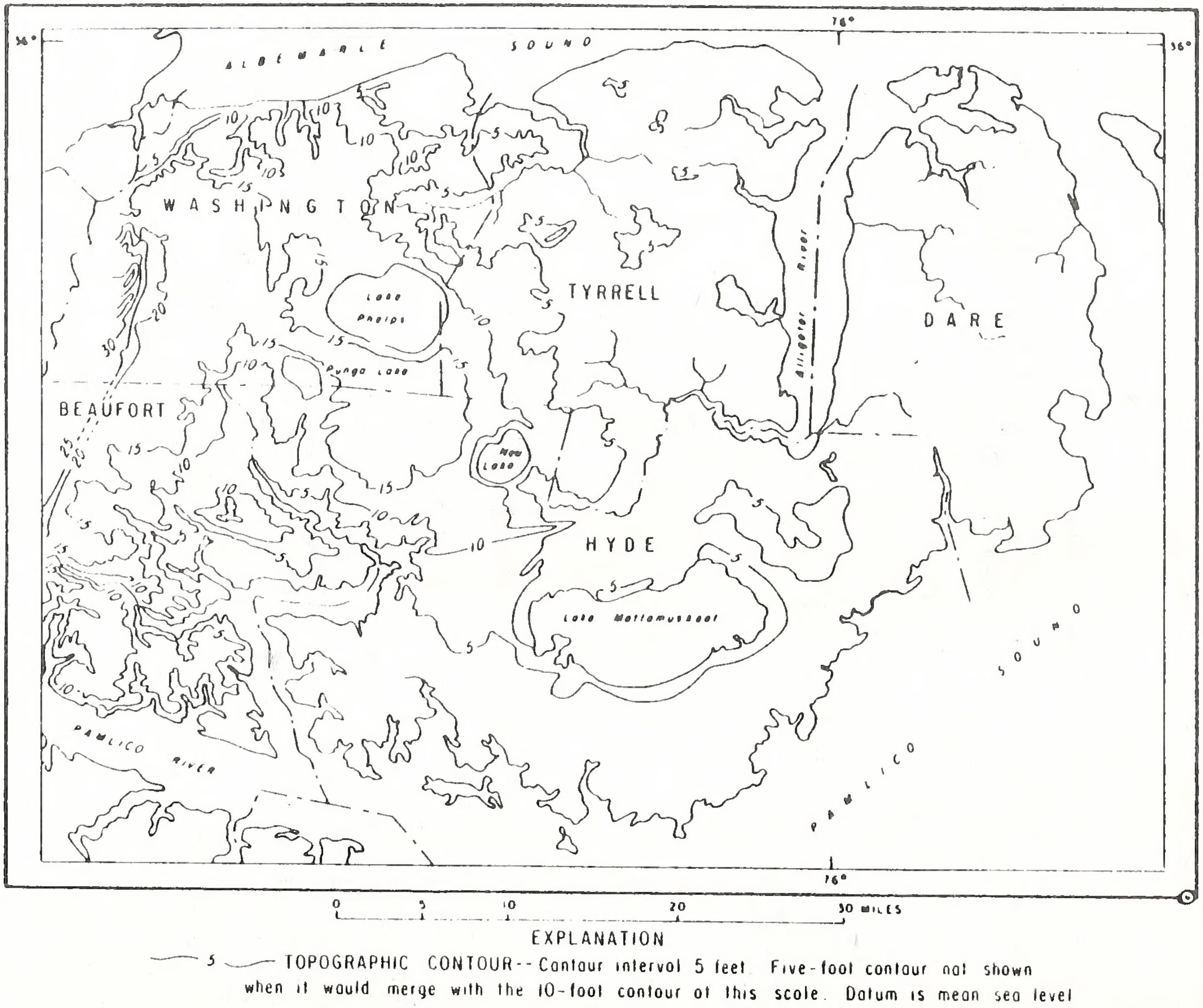


Figure 5C: Generalized topographic map of the Albemarle-Pamlico Peninsula

(from Heath, 1975)

5.2.2.3 Mining and Processing Technologies

5.2.2.3.1 Mining Technologies in Use

Area 1
- Milled peat production (15,012 acres permitted)
- Bulldozer, truck, and front-end loader (98 acres permitted)
- Scrape mining (similar to milled method) (708 acres permitted)

Area 2
- Milled peat production (7,142 acres permitted)

Sources:
- Mining Permit Applications

5.2.2.3.2 Average Amount of Peat Mined Per Year at Years 10 and 20

Area 1	525,000 dry tons (875,000 tons at 40% moisture)
Area 2	140,000 dry tons (235,000 tons at 40% moisture)
Total	665,000 dry tons (1,110,000 tons at 40% moisture)

Assumptions:
- 140 mining days per year (average)
- Amount of peat mined is based on:
  - Area 1: 3,600 dry tons/day x (average) 140 mining days-peat for methanol production
    25,00 dry tons/year-horticultural peat
  - Area 2: 1,000 dry tons/day x (average) 140 mining days

Source:
- PMA, 1983d, p.14 (harvesting projected to take place 142 days per year)

5.2.2.3.3 Processing Technologies in Use at Years 10 and 20

Area 1
Conversion to methanol (500,000 dry tons per year)
Export as horticultural peat (25,000 dry tons per year)

Area 2
Export to industry as peat for fuel (140,000 dry tons per year)

Assumption:
Area 2: export of peat to off-peninsula industry for use as fuel

Sources:
Mining Permit Applications

5.2.2.3.4 Products from Mined Peat: Type and Amount at Years 10 and 20

Area 1	
methanol	60 million gals/year
horticultural peat	25,000 dry tons/year
Area 2	
peat for industrial use (fuel)	140,000 dry tons/year

Assumptions:
Area 1: methanol plant annual output is equivalent to approximately 310 days per year at full capacity requiring an average of 1,600 dry tons peat per day to produce an average of 200,000 gallons of methanol per day

Area 2: peat for industrial use is mined/produced 140 days per year

Sources:
PMA documents

5.2.2.4 Transportation

5.2.2.4.1 Type and Maximum Volume of Transportation to and on Site (Construction and Operation)

	Type	Size	Number/day
Area 1	heavy duty trucks	up to 36 tons	40 (construction) 13 (operation)
Area 2	trucks	up to 36 tons	5 (operation)

Assumptions:
  Years 1-3: construction ongoing in Area 1
  Years 4-20: no construction ongoing in Area 1
  No construction required in Area 2
  Operation excludes transportation of peat or peat products. Refers primarily to transportation of slag and fly ash (Area 1).
  Number of trucks needed in Area 2
Source:
  PMA, 1983j, p. 25

5.2.2.4.2 Type and Volume of Transportation on Site - Harvesting (Years 1-20)

	Type	Volume
Area 1	tractor & carts (15 ton capacity)	233 loads/day to methanol plant stoarge pile or shipping area for horticultural peat
Area 2	tractor and carts (15 ton capacity)	63 loads/day to shipping area

Assumptions:
  Assumes peat can be transported from mining site to processing plant or shipping area 250 days/year
  Transportation method and capacity in Area 2
Calculations:
  Area 1: 875,000 tons of peat at 40% moisture per year/15 tons per cart/250 days per year
  Area 2: 235,000 tons of peat at 40% moisture per year/15 tons per cart/250 days per year
Source:
  PMA, 1983i, p. 22- peat to be transported from the mining site to the plant stockpile an average of 251 days per year

5.2.2.4.3 Type, Volume, and Route of Transportation from Site - Products at Years 10 and 20

	Number	Type	Size	Route
Area 1	27/day	trucks	36-ton	Rte 64 to Plymouth, NC
Area 2	2/week	barges	1,500-ton	IWW (south)

Assumptions:
Peat from Area 2 is transported via barge through the IWW to a major industry off the peninsula (50 weeks/year)
Horticultural peat and methanol from Area 1 is transported to barge and RR facilities in Plymouth, NC
Source:
PMA, 1983j, pp. 44 & 73

5.2.2.4.4 Maximum Distance (Miles) Peat Transported on Unpaved Roads on Site

	at 10	at 20
Area 1	2.5	4
Area 2	4	4

Assumptions:
Distances for Area 2
Source:
PMA, 1983d, Fig. 4-1, general phases of mining (used phase II for at 10/phase V for at 20)

5.2.2.4.5 Distance Products Transported on Paved/Unpaved Roads from Site (Miles) Years 1-10

	paved	unpaved	total	destination
Area 1	19	10	29 (one way)	Plymouth, NC
Area 2	0	0	0	

Assumptions:
All peat products from Area 1 are transported to or through Plymouth, NC and all peat from Area 2 is transported to a major industry off the peninsula via barge on the IWW (from a barge terminal adjacent to the mining site)
Road on northern edge of Area 1 mining site remains unpaved
Source:
PMA, 1983j

5.2.2.5 Water Management

5.2.2.5.1 Acreage of Sediment, Evaporation, and Other Temporary Ponds and Acreage of Permanent Lakes

	1-9	10-20
Area 1	2550 (temp-max depth 3')	1450 (perm-max depth 8')
Area 2	0	0

Assumptions:
All drainage water from Area 2 is discharged into IWW/no holding ponds
Note:
Area 1: holding ponds located on 15,012 acre tract in methanol production
Sources:
PMA, 1983c, d
PMA, 1983i, p. 19

5.2.2.5.2 Groundwater Withdrawn from the Quarternary Shell Hash Unit for Processing at Years 10 and 20

Area 1	2.3 mgd
Area 2	none

Assumptions:
Withdrawals are made from the Quarternary Shell Hash Unit (underlying Area 1 at depths of 40 to 130 feet)

Sources:
PMA, 1983i, p. 74 and personal communication R. Hornstein, Koppers Company, Inc.

5.2.2.5.3 Maximum Water Withdrawn from the Surficial Aquifer during Plant Site Preparation

Area 1	3 mgd (for a period of two years)
Area 2	0 mgd

Sources:
PMA Water Use Permit Applications and Permits

5.2.2.5.4 Water Balances for Mining Sites

Condition	Total mgy/2000 acres (Area 1)	Runoff mgy/1500 acres (Area 2)	Subsurface Drainage (in^3/in^2)	Surface Runoff (in^3/in^2)	Evapo-trans-piration (in^3/in^2)
Pre-mining (disturbed)	1046	784	11.2	8.0	29.2
Pre-mining (shrub)	778	591	11.1	3.4	33.9
During mining	1336	1002	6.5	18.0	
After mining (agriculture 330' spaced drainage ditches)	808	606	6.8	8.0	33.6

Note:
Data based on 15 year averages of computer simulations using weather data from Elizabeth City weather station. Annual average rainfall for the 15 years used is 48.4''.

Source:
R. Broadhead, Dept. Biol. and Agric. Eng., NCSU

5.2.2.5.5 Mined and Reclaimed Acreage from Which Drainage Water is Being Pumped during Mining (Cumulative)

	0-5	5-10	10-15	15-20
Area 1	3,080	5,520	8,920	11,360
Area 2	1,500	3,000	4,500	6,000
Total	4,580	8,520	13,420	17,360

Assumptions:

- All disturbed acreage requires pumping during mining (i.e., drainage water from all lands gravity drains to lowest points on the mining sites and is pumped into lakes or canals)
- All reclaimed acreage requires pumping
- Acreage figures do not include unmined land which may drain into the low points depending on the location of the unmined land relative to the sites being mined

Sources:

L. Otte, Geol. Dept., ECU
R. Broadhead, Dept. Biol. and Agric. Eng., NCSU

5.2.2.5.6 Maximum Changes in Surficial Groundwater at the Mine Sites

Areas 1 and 2

In areas where peat is removed, groundwater levels will decline by the depth of peat mined. If vegetation is replanted, groundwater level will drop an additional foot.

Source:

R. Broadhead, Dept. Biol. and Agric. Eng., NCSU

Area 1

Projected maximum effects of mining operations on water levels along the northern edge of the mining site are a decline of about 3.5' in the Fine Sand Unit and 2.5' in the Shell Hash Unit.

Source:

PMA, 1983k, p. 84

5.2.2.5.7 Drainage and Runoff Waters from All Mined and Reclaimed Lands: Direction of Flow/Receiving Body of Water

	1-10	11-20
Area 1	All runoff to temp. lagoons or central lake to Canal B to Pungo River (Mean annual discharge from holding ponds: 8 cfs Max. runoff: 59.6 cfs)	All runoff to central lake to Canal B to Pungo River (Mean annual discharge from lake: 35.3 cfs Max. runoff: 151 cfs)
Area 2	Mine site to IWW	Same as 1-10

Assumptions:

Drainage systems on all mined lands similar to agricultural drainage systems in use throughout the coastal area of NC

Area 1: Water will drain from disturbed areas by gravity to low points from which it will be pumped to lagoons or a central lake

Area 2: Water will be discharged into IWW

Sources:

PMA, 1983f, p. 6-74

WTF NPDES Permit

PMA, 1983i, p. 91

5.2.2.5.8 Quality of Runoff from Mining Sites (Areas 1 and 2)

Source Water Type	Parameters (all units except pH in mg/l (ppm) +/- approx. S.E.) DO	pH	TSS	CN^-	SCN^-
1 Drainage (Measured in existing canals)	3 +/-0.6	4.2 +/-0.4	25 +/-8	<0.005	2 +/-0.7
2 Drainage (Mean effluent characteristics projected from harvesting)	-	4.3-8.5	100 (200 max)	-	-
3 Processing Effluent	7 (80% sat. at 20 C)	6-9	-	0.002	-
4 Storm	-	6-9	50	-	-
5 Drainage ("natural peatlands")	-	-	-	-	-
6 Drainage (peatlands converted to pasture)	-	-	-	-	-

Note:
Abbreviations may be found in Appendix 10.10

Sources:
1- PMA, 1983f, Appendix A
2,3,4- PMA, 1983f
5,6- Skaggs et al., 1980
7- NRCD unpublished data

5.2.2.5.8 (Continued)

Source	Water Type	Parameter (mg/l (ppm) +/- approx. S.E.)				
		Cl^-	Fl^-	$SO_4^=$	NH_3-N	NO_2-N
1	Drainage	12 +/-2	0.1 +/-0.02	12 +/-2	1.0 +/-0.2	0.01
2	Drainage	-	-	-	0.96	-
3	Process	-	1.4	-	-	-
5	Drainage	2.2	-	-	0.11 +/-0.01	-
6	Drainage	9.2	-	-	0.36 +/-0.04	-

Source	Water Type	NO_3-N	Kjd-N	Tot Org-N	Ortho-P	Tot-P
1	Drainage	0.01	3.5 +/-0.4	2 +/-0.2	0.2 +/-0.04	0.3 +/-0.03
2	Drainage	-	-	-	0.01	-
3	Process	-	-	-	-	0.5
5	Drainage	0.03 +/-0.01	1.18 +/-0.04	1.20 +/-0.03	-	0.006 +/-0.01
6	Drainage	0.24 +/-0.07	1.68 +/-0.04	1.92 +/-0.09	-	2.36 +/-0.21

Note:
Abbreviations may be found in Appendix 10.10
Sources:
1- PMA. 1983f, Appendix A
2,3,4- PMA, 1983f
5,6- Skaggs, et al., 1980
7- NRCD unpublished data

5.2.2.5.8 (Continued)

Source	Water Type	Parameter (mg/l (ppm) +/- approx. S.E.)					
		5 Day BOD	As	Sb	Ca	Cd	Cu
1	Drainage	2.5	<0.02	<0.02	10 +/-4	0.002	0.01
2	Drainage	4 (max 6)	-	-	-	-	0.02
3	Process	6	0.003	-	-	0.001	-
5	Drainage	-	-	-	1.4	<0.01	0.012
6	Drainage	-	-	-	10.4	<0.01	0.009

Source	Water Type	Fe*	Cr	Mn	Mg	Pb**	Hg
1	Drainage	5 +/-1.3	0.005	0.03	3 +/-1	0.02	0.001 +/-0.002
2	Drainage	4.9	-	-	-	-	"ambient"
3	Process	<0.001	0.01	0.02	-	<0.001	0.00021
5	Drainage	0.63	-	0.003	0.5	-	-
6	Drainage	1.66	-	0.027	2.5	-	-
7	?	-	-	-	-	-	<0.0002

Notes:
* > criterion (1 & 2)
** much variation, sometimes > criterion (0.03?)
Abbreviations may be found in Appendix 10.10

Sources:
1- PMA, 1983f, Appendix A
2,3,4- PMA, 1983f
5,6- Skaggs et al., 1980
7- NRCD unpublished data

5.2.2.5.8 (Continued)

Source	Water Type	Parameter (mg/l (ppm) +/- approx. S.E.)							
		Ni	Se	Ag	Na	Zn	Co	Be	D.S.
1	Drainage	<0.01	<0.001	<0.001	6	0.08	<0.01	-	250
3	Process	0.07	0.001	-	-	0.09	<0.001	<0.005	4500
5	Drainage	-	-	-	3.7	0.01	-	-	-
6	Drainage	-	-	-	5.1	0.02	-	-	-

Note:
Abbreviations may be found in Appendix 10.10
Sources:
1- PMA, 1983f, Appendix A
2,3,4- PMA, 1983f
5,6- Skaggs et.al., 1980.
7- NRCD unpublished data

5.2.2.5.9 Wastewater Treatment: Source/Rate/Route of Effluent Discharge/Receiving Body of Water at Years 10 and 20

	Source	Average Daily Discharge	Route	Receiving Water Body
Area 1	Methanol plant	870,000 gal/day	Canal B	Pungo R.
Area 2	none			

Assumption:
No processing occurs in Area 2
Source:
PMA, 1983i

5.2.2.5.10 Flood Gates/Flood Control Measures

Area 1
No flood gates constructed because of elevation of permitted land

Area 2
Flood gates constructed at all drainage outlets from mining sites to permit site drainage but prevent entry of water from IWW

Assumptions:
Flood gates constructed in Area 2
Sources:
WTF Mining Permit
R. Hornstein, Koppers Co., Inc.

5.2.2.5.11 Elevation of Dikes Around Mined Areas/Storage Ponds and Lakes

	at 10	at 20
Area 1	20' MSL around temp ponds	20' MSL around central lake
Area 2	no dikes	8' MSL around eastern end of mine

Sources:
PMA, 1983d
WTF Mining Permit

5.2.2.5.12 Probability of Hurricane Flooding in 100-year Floodplain at Years 10 and 20

Area 1
Not susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year

Area 2
Approximately half the area is susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year (without protective barriers)

Source:
Figure 5D

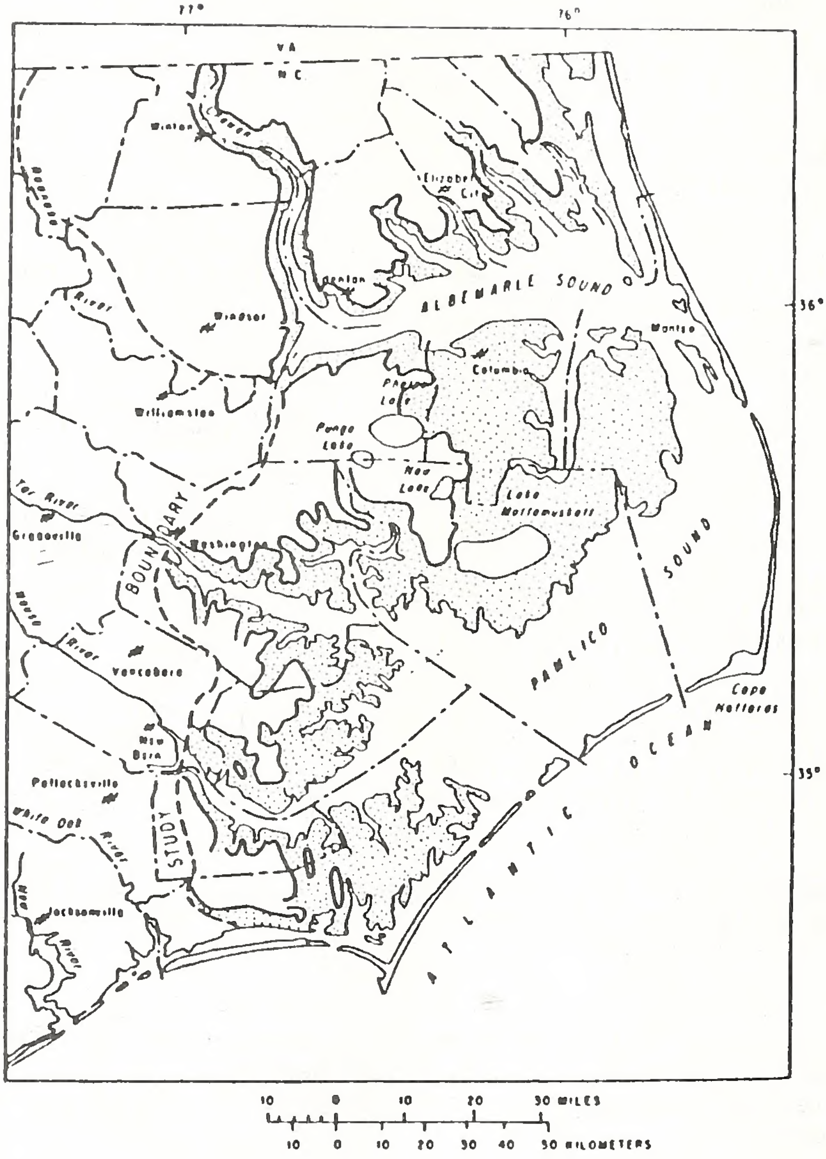


Figure 5D: Area subject to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year (from Wilder, Robison and Lindskov, 1978)

5.2.2.5.13 Change in Groundwater Recharge Rate to the Castle Hayne Aquifer Resulting from Land Clearing and Mining Activities. Values are Average Changes in Recharge Rates Over the Entire Acreage for Each Area.

	1-10	11-20	Over 20years
Area 1	-0.0005 in/yr (-5.2%) -66gpd	-0.0002 in/yr -230 gpd	-0.0007 in/yr (-7.2%) -830 gpd
Area 2	-0.0007 in/yr (-7.6%) -400 gpd	-0.0001 in/yr -60 gpd	-0.0009 in/yr (-8.8%) -460 gpd

Notes:

Rate at year 0 = 0.01 in/yr

Change in rate is noted in parentheses

Assumptions:

Assumes layers are isolated laterally (i.e., essentially a vertical system)

Stratigraphy for all areas similar to that found for First Colony Farms (Area 1)

Depth of mining operations for all areas similar to that proposed by PMA (Area 1)

Source:

Foutz, 1983.

5.2.2.5.14 Salt water Encroachment in Shallow and Deep Aquifers

Areas 1 and 2

No significant lateral movement in the freshwater/saltwater interface. Since there is already a wide diffused zone ranging from salt to fresh water, the anticipated change in head due to withdrawals (a few feet) is not expected to significantly change the location of this diffused zone

Sources:

P. Nelson, Groundwater Section, DEM, NRCD

PMA, 1983k

5.2.2.5.15 Revegetation of Canal/Ditch Banks

Revegetation is completed following ditch maintenance and as part of reclamation

Assumption:

All of the above

5.2.2.5.16 Erosion and Sediment Control Measures

Adequate mechanical barriers including but not limited to diversions, settling ponds, earthen dikes, brush barriers, silt check dams, silt retarding structures; rip rap pits or ditches provided in the initial stages of any land disturbance to prevent sediment from discharging onto any adjacent surface areas or into any lake or natural watercourse in proximity to the affected land.

Assumptions:
All of the above

5.2.2.5.17 Buffer Strips Adjacent to Estuaries/Lakes/Rivers at Years 10 and 20

Area 1	2000' tree buffer between site and Phelps Lake
Area 2	300' between site and IWW

Note: 2000' tree buffer in Area 1 is outside permitted area

Sources:
PMA, 1983f
WTF Mining Permit

5.2.2.6 Air Quality Management

5.2.2.6.1 Off-property Fugitive Dust Concentrations Resulting from Mining and Processing Operations at Years 10 and 20

With adequate buffer strips, mining in Areas 1 and 2 is not anticipated to exceed air quality standards.

Notes:
NC Air Quality Standards
Area 1 (15,012 acre tract)
Annual Standard for Particulate - 75 $\mu g/M^3$
24-Hour Standard for Particulate - 150 $\mu g/M^3$
Area 1 (all other acreage) and Area 2
Annual Standard for Particulate (Class I) - 5 $\mu g/M^3$
24-Hour Standard for Particulate (Class I) - 10 $\mu g/M^3$
Annual Standard for Particulate (Class II) - 19 $\mu g/M^3$
24-Hour Standard for Particulate (CLass II) - 37 $\mu g/M^3$
Class I - protected areas having air cleaner than the National Ambient Standard (Swanquarter National Wildlife Refuge is the only Class I area on the Albemarle-Pamlico Peninsula)
Class II - other areas having air cleaner than the National Ambient Standard
$\mu g/M^3$ = micrograms per cubic meter
Source:
M. Sewell, Air Quality Section, DEM, NRCD

5.2.2.6.2 Mitigation Measures for Fugitive Dust Emissions from Transportation of Peat in Use at Years 10 and 20

Area 1
- restricted speed limits
- paving or watering of roadways
- tree buffer strips

Area 2
- restricted speed limits
- tree buffer strips

Assumptions:
All of the above
Source:
PMA, 1983j, p. 78

5.2.2.7 Solid Waste Management

5.2.2.7.1 Amount of Non-hazardous Waste Generated (Years 1-20)

Area 1 53,000 tons/yr (851,000 ft^3/yr*)
(non-burnable material from methanol production including 27,000 tons/year of slag and fly ash)
Area 2 negligible

Assumptions:
* Assumes a bulk density of 0.062 tons/ft^3
No significant amount non-hazardous waste generated in Area 2
Source:
PMA, 1983h, Fig. 1

5.2.2.7.2 Amount of Hazardous Waste Generated (Years 1-20)

Area 1 1,000 ft^3/yr (does not include catalysts recycled)
8,100 gals/yr waste oils

Area 2 none

Assumption:
No hazardous wastes generated in Area 2 since no peat will be processed on site
Source:
PMA, 1983h

5.2.2.8 Wildlife Mitigation Measures

5.2.2.8.1 Permitted Acreage Restored to Native Vegetation (Buffer Strips)

see section 5.2.2.10.6

Assumption:
20% mined/reclaimed land required re-established to native vegetation or low intensity managed forest for buffer strips
Source:
D. Owens, Office of Coastal Management, NRCD

5.2.2.8.2 Location of Native Vegetation Buffer Strips on Permitted Areas at Years 10 and 20

see Figure 5E

Source:
PMA, 1983c, d

5.2.2.9 Fire Protection Measures

5.2.2.9.1 Source and Volume of Water for Fire Suppression

	1-10	11-20
Area 1	Canals, lagoons- 14 unharvested blocks in use as water storage reservoirs	Central lake (5 blocks) (12,000 ac-ft)
Area 2	Fire protection/waterfowl impoundment	same as at 10

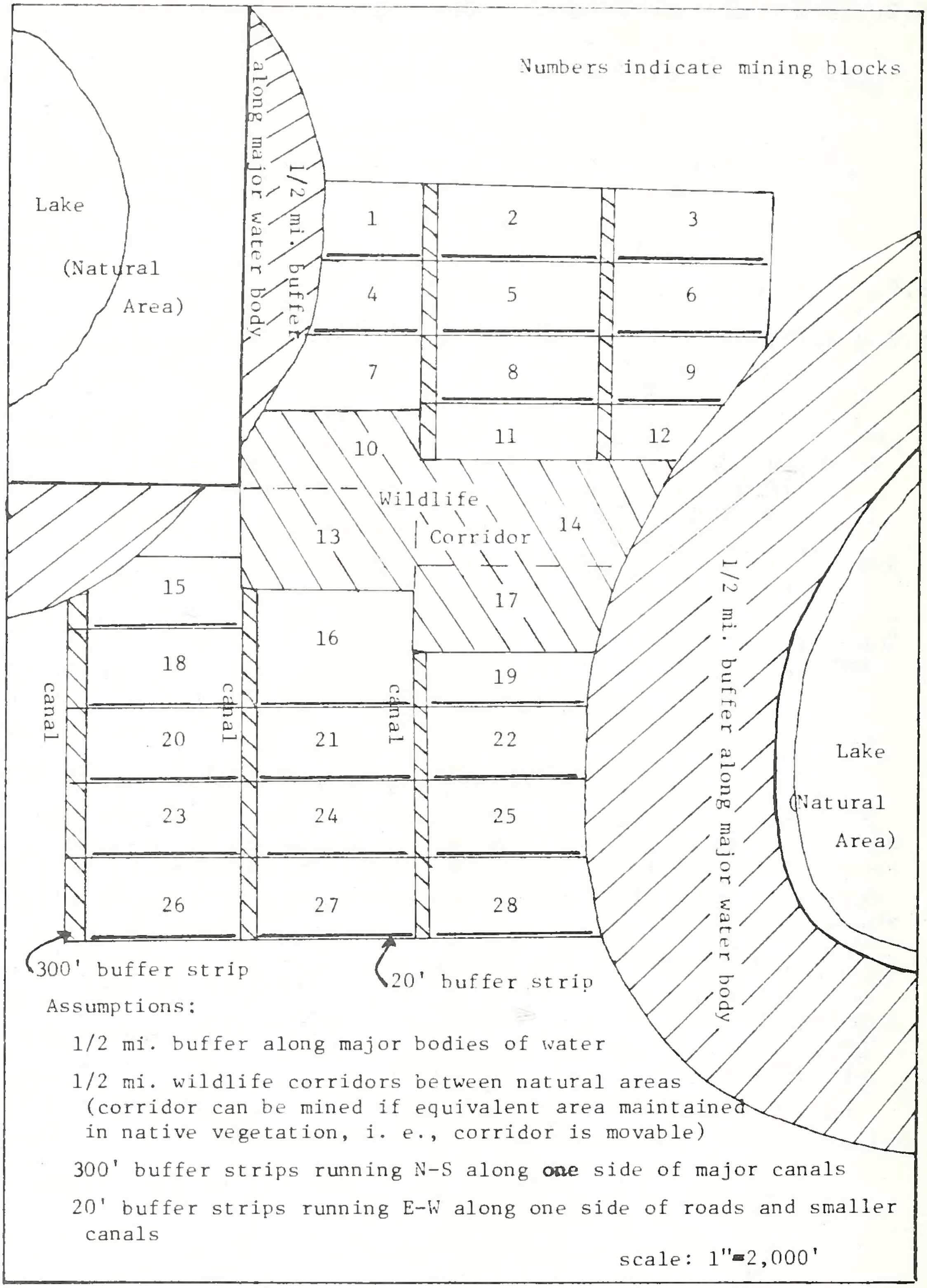
Source:
PMA, 1983c, pp. 13, 37

5.2.2.9.2 Water Control Structures for Areas Not Being Mined

Structures installed to prevent gravity drainage from lowering water level lower than 1' below ground level on lands not being actively mined. These structures have capacity to retain sufficient water to flood or saturate peat soil to or slightly above ground level.

Assumptions:
All of the above

Sources:
PMA, 1983c, p. 13
WTF Mining Permit



Assumptions:

1/2 mi. buffer along major bodies of water

1/2 mi. wildlife corridors between natural areas (corridor can be mined if equivalent area maintained in native vegetation, i. e., corridor is movable)

300' buffer strips running N-S along one side of major canals

20' buffer strips running E-W along one side of roads and smaller canals

scale: 1"=2,000'

Figure 5E: Schematic of typical wildlife buffer plan

5.2.2.10 Reclamation

5.2.2.10.1 Mined Acreage Legally Required to be Reclaimed (Cumulative)

	by 10	by 20
Area 1	2,020	7,980
Area 2	1,500	4,500
Total	3,500	12,480

Assumptions:
NRCD requirement that mined areas be reclaimed within 2 years of completion of mining is met
All legally reclaimable land reclaimed on schedule (refers to sections 5.2.2.10.3-5.2.2.10.8)
Reclamation schedule for Area 2 and part of Area 1
Source:
PMA, 1983d, Fig. 2-10

5.2.2.10.2 Percentage of Total Reclaimed Land in Various Types of Reclamation

	Area 1		Area 2
	by 10	by 20	by 10 and 20
Row crops with pumping	8	62	78
Row crops without pumping	0	0	0
Pine plantations	10	10	10
Restored native veg.	10	10	10
Open water	72	18	0
Grass replanted	0	0	2

Assumptions:
Native vegetation restored in buffer strips as shown in Figure 5E
Pumping required in all reclaimed farmland
Reclamation activities - percentages

5.2.2.10.3 Mined Acreage in Row Crops with Pumping (Cumulative)

	by 10	by 20
Area 1	162	4,930
Area 2	1,170	3,510
Total	1,332	8,440

Calculations:
Sections 5.2.2.10.3-5.2.2.10.8 calculated based on % in section 5.2.2.10.2 and acreages in section 5.2.10.1

5.2.2.10.4 Mined Acreage in Row Crops Without Pumping (Cumulative)

	by 10	by 20
Area 1	0	0
Area 2	0	0
Total	0	0

5.2.2.10.5 Mined Acreage in Pine Plantations (Including Vegetative Buffer Strips) (Cumulative)

	by 10	by 20
Area 1	202	798
Area 2	150	450
Total	352	1,248

5.2.2.10.6 Mined Acreage Restored to Native Vegetation (Buffer Strips) (Cumulative)

	by 10	by 20
Area 1	202	798
Area 2	150	450
Total	352	1,248

5.2.2.10.7 Mined Acreage in Open Water Reclamation With/Without Marshes and Islands (Cumulative)

	by 10	by 20
Area 1	1,454	1,454
Area 2	0	0
Total	1,454	1,454

5.2.2.10.8 Mined Areas Replanted to Grass (Cumulative)

	by 10	by 20
Area 1	0	0
Area 2	30	90
Total	30	90

5.2.2.10.9 Unreclaimed Mined Acreage Not Yet Legally Required to be Reclaimed (Cumulative)

	by 10	by 20
Area 1	3,500	3,380
Area 2	1,500	1,500
Total	5,000	4,880

5.2.2.10.10 Unreclaimed Disturbed Acreage Legally Required to be Reclaimed (Cumulative)

	by 10	by 20
Area 1	0	0
Area 2	0	0
Total	0	0

Assumption:
All legally reclaimable land reclaimed on schedule

5.2.3 Scenario #2: Upper Boundary

(Static: at years 1/10/20 and/or Cumulative: years 1-10 and 11-20)

5.2.3.1 Permitted Mining Activity

5.2.3.1.1 Permitted Acreage

	year 1	10	20
Area 1			30,000
Area 2			15,000
Area 3			26,000
Area 4			13,000
Total			84,000

Assumptions:
All of the above
Source:
Figure 5F

5.2.3.1.2 Location of Permitted Acreage

see Figure 5G

5.2.3.2 Land Disturbance

5.2.3.2.1 Acreage Mined (Cumulative)

	by 10	by 20
Area 1	7,500	30,000
Area 2	3,750	15,000
Area 3	5,500	26,000
Area 4	3,400	13,000
Total	20,150	84,000

Assumptions:
Mining start dates and rates occur as indicated in Scenario #2 chart of disturbed acreages
Source: Figure 5F

Figure 5F: Scenario #2-- Acreage disturbed

	Year				Total
	1 2 3 4 5	6 7 8 9 10	11 12 13 14 15	16 17 18 19 20	
Area 1 Permitted: 30,000 ac. Mined 30,000 ac.	3,000	4,500	9,000	13,500	30,000 ac.
Area 2 Permitted: 15,000 ac. Mined: 15,000 ac.	1,500	2,250	4,500	6,750	15,000 ac.
Area 3 Permitted: 26,000 ac. Mined: 26,000 ac.	1,500	4,000	8,000	12,500	26,000 ac.
Area 4 Permitted: 13,000 ac. Mined: 13,000 ac.	1,500	1,900	3,850	5,750	13,000 ac.
Maximum Acreage Disturbed	20,150		63,850		84,000 ac.

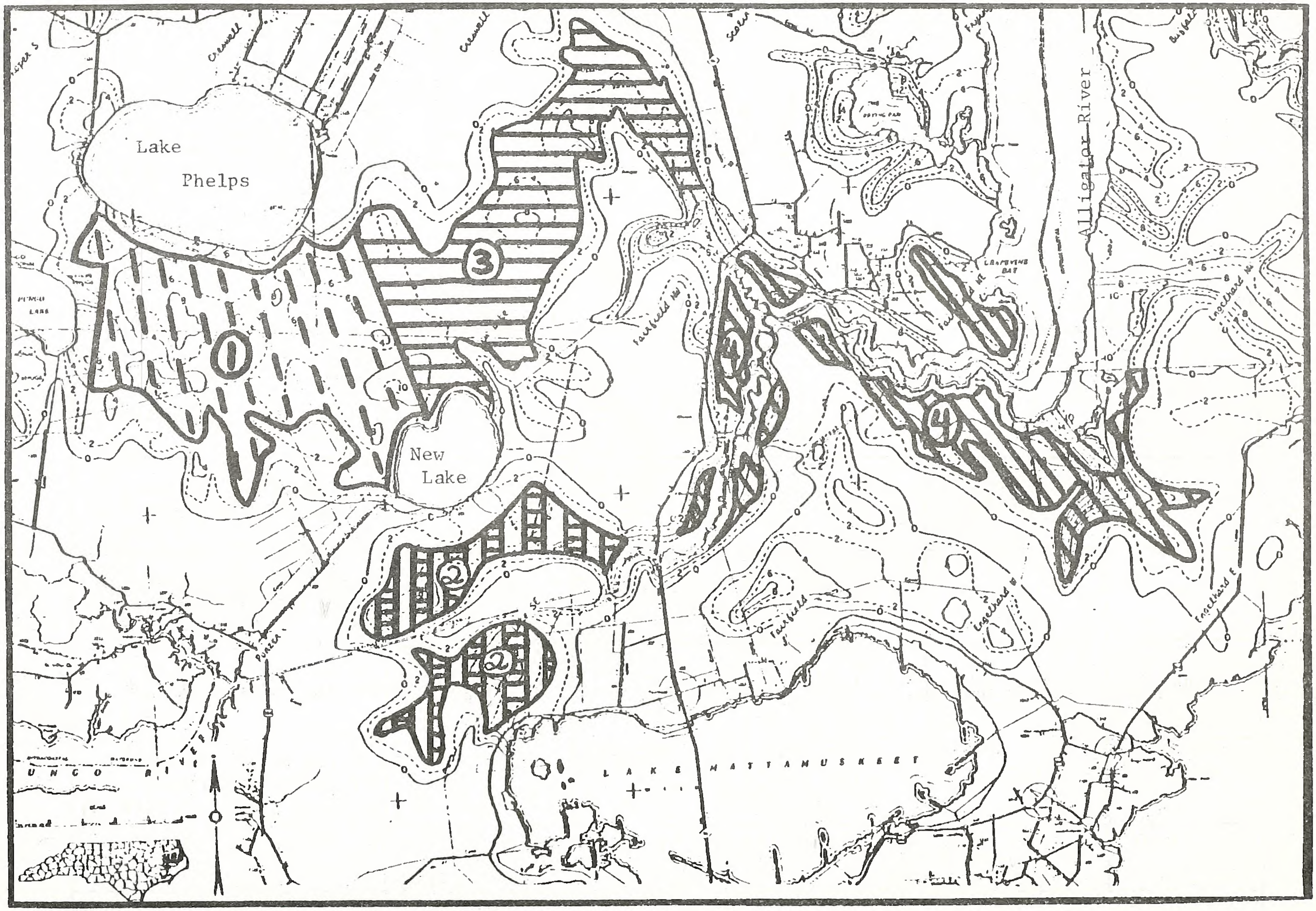


Figure 5G: Scenario #2-- Upper Boundary

(Basemap - Isopach map of Pamlimarle peat - 2 ft thickness interval - from Ingram and Otte, 1982)

Key:

Area 1 ▥ 30,000 ac
Area 2 ▦ 15,000 ac
Area 3 ▤ 26,000 ac
Area 4 ▧ 13,000 ac

5.2.3.2.2 Average Acreage in Peat Mining Production at Any One Time

	1-10	11-20
Area 1	3,750	11,250
Area 2	1,875	5,625
Area 3	2,750	10,250
Area 4	1,700	4,800
Total	10,075	31,925

Source:
Figure 5F

5.2.3.2.3 Maximum Acreage Disturbed (in Preparation or Being Mined) at Any One Time

	at 10	at 20
Area 1	4,500	13,500
Area 2	2,250	6,750
Area 3	4,000	12,500
Area 4	1,900	5,750
Total	12,650	38,500

Source:
Figure 5F

5.2.3.2.4 Average Annual Rate of Land Disturbance

	1-5	6-10	11-15	16-20
Area 1	600	900	1,800	2,700
Area 2	300	450	900	1,350
Area 3	300	800	1,600	2,500
Area 4	300	380	770	1,150

Assumptions:
Mining rates
Source:
Figure 5F

5.2.3.2.5 Elevation of Mined Acreage

	Land Elev. (MSL)	Maximum Mine Depth	Average Depth of Mining	Minimum Elev of Mined Acreage (MSL)
Area 1	13-18'	10'	4-5'	4'
Area 2	5-10'	9'	4-6'	1'
Area 3	<5-15'	8'	4-6'	3' below MSL
Area 4	5' or less	14'	4-8'	9' below MSL or lower

Sources:
Maximum depth of peat deposits estimated from Ingram and Otte, 1982
Elevations - see Figure 5C

5.2.3.2.6 Undisturbed Permitted Acreage at Year 20

Area 1	0
Area 2	0
Area 3	0
Area 4	0
Total	0

5.2.3.3 Mining and Processing Technologies

5.2.3.3.1 Mining Technologies in Use

Area 1
Milled peat production (28,300 acres permitted)
Bulldozer, truck, and front-end loader (200 acres permitted)
Scrape mining (similar to milled method) (1,500 acres permitted)

Area 2
Milled peat production (15,000 acres permitted)

Area 3
Milled peat production (26,000 acres permitted)

Area 4
Milled peat production (13,000 acres permitted)

Assumption:
Hydraulic mining not in use/feasible

5.2.3.3.2 Average Amount of Peat Mined (dry tons/yr)

	at 10	at 20
Area 1	837,525	2,512,575
Area 2	367,500	1,102,500
Area 3	471,900	1,758,900
Area 4	432,000	1,219,000
Total	2,108,925	6,592,975

Calculations:

Area 1: Estimated peat contained within area boundaries - 33.5 million dry tons
33.5 million tons/30,000 ac=1,116.7 tons/ac
yrs 1-10: 7,500 ac mined x 1,116.7 tons/ac/10 yrs=837,525
yrs 11-20: 22,500 ac mined x 1,116.7 tons/ac/10 yrs=2,512,575 tons/yr

Area 2: Estimated peat contained within area boundaries - 14.7 million dry tons
14.7 million tons/15,000 ac=980 tons/ac
yrs 1-10: 3,750 ac mined x 980 tons/ac/10 yrs=367,500 tons/yr
yrs 11-20: 11,250 ac mined x 980 tons/ac/10 yrs=1,102,500 tons/yr

5.2.3.3.2 (Continued)

Area 3: Estimated peat contained within area boundaries -
22.3 million dry tons
22.3 million tons/26,000 ac=858 tons/ac
yrs 1-10: 5,500 ac mined x 858 tons/ac/10 yrs=471,900 tons/yr
yrs 11-20: 20,500 ac mined x 858 tons/ac/10 yrs=1,758,900 tons/yr

Area 4: Estimated peat contained within area boundaries -
16.5 million dry tons
16.5 million tons/13,000 ac=1,270 tons/ac
yrs 1-10: 3,400 ac mined x 1,270 tons/ac/10 yrs=432,00 tons/yr
yrs 11-20: 9,600 ac mined x 1,270 tons/ac/10 yrs=1,219,000 tons/yr

Note:
Tonnages by area roughly estimated based on data provided by R. L. Ingram - square miles of peat by depth by USGS quad map. Bulk density assumed to be 180 tons/acre-foot.

5.2.3.3.3 Processing Technologies in Use

Method	Dry Tons/Year at 10	at 20
Area 1		
Conversion to methanol	787,273	2,361,821
Export as horticultural peat	50,252	150,754
Area 2		
Export to industry as peat for use as fuel	367,500	1,102,500
Area 3		
Conversion to methanol	471,900	1,758,900
Area 4		
Export to industry as peat for use as fuel	432,000	1,219,000

Calculations:
see section 5.2.3.3.2

5.2.3.3.4 Products from Mined Peat: Type and Amount

	at 10	at 20
Area 1		
methanol	94 million gal/yr	283 million gals/yr
horticultural peat	50,252 dry tons/yr	150,754 dry tons/yr
Area 2		
peat for industrial use (fuel)	367,500 dry tons/yr	1,102,500 dry tons/yr
Area 3		
methanol	57 million gals/yr	211 million gals/yr
Area 4		
peat for industrial use (fuel)	432,000 dry tons/yr	1,219,000 dry tons/yr

Assumption:
8,333 dry tons of peat produce 1 million gallons of methanol (based on Scenario #1, section 5.2.2.3.4)

5.2.3.4 Transportation

5.2.3.4.1 Type and Maximum Volume of Transportation to and on Site (Construction and Operation)

	Type	Size	Number/day
Area 1	heavy duty trucks	up to 36 tons	80 (construction) 26 (operation) at year 10 65 (operation) at year 20
Area 2	trucks	up to 36 tons	10 (operation) at year 10 30 (operation) at year 20
Area 3	heavy duty trucks	up to 36 tons	75 (construction) 25 (operation) at year 10 65 (operation) at year 20
Area 4	trucks	up to 36 tons	10 (operation) at year 10 33 (operation) at year 20

Assumptions:
Areas 2 and 4: no construction required
Areas 1 and 3: construction ongoing years 1-10
Years 11-20: no construction ongoing
Operation excludes transportation of peat or peat products. For Areas 1 and 3 refers primarily to transportation of slag and fly ash

5.2.3.4.2 Type and Volume of Transportation on Site - Harvesting

1-5

	Type	Volume
Area 1	tractor & carts (15-ton capacity)	233 loads/day to plant storage pile
Area 2	same as above	98 loads/day to shipping area
Area 3	same as above	126 loads/day to plant storage pile
Area 4	same as above	115 loads/day to shipping area

Assumptions:

Assumes peat can be transported from mining site to processing plant or shipping area 250 days/year

Years 6-20: switch to conveyers for transportation of peat to plant storage piles or shipping areas (all Areas)

Source:

PMA, 1983i, p. 22 peat to be transported from the mining site to the plant stockpile an average of 251 days per year

5.2.3.4.3 Transportation from Site - Products at Years 10 and 20

	Type	Route
Area 1	pipelines	to Plymouth, NC
Area 2	barges	IWW (south)
Area 3	pipelines	to Plymouth, NC
Area 4	barges	IWW (south)

Assumptions:

Peat from Areas 2 + 4 is transported via barge through the IWW to major industries off the peninsula

Methanol from Areas 1 + 3 is transported via pipeline to barge and RR facilities in Plymouth, NC

5.2.3.4.4 Maximum Distance (Miles) Peat Transported on Unpaved Roads on Site (Years 1-5)

Area 1	5
Area 2	8
Area 3	6
Area 4	8

Assumption:
Years 6-20: conveyers in use for transportation of peat in all areas

5.2.3.4.5 Maximum Distance Products Transported on Paved/Unpaved Roads from Site (Miles)

	paved	1-10 unpaved	total	destination
Area 1	0	0	0	Plymouth, NC
Area 2	0	0	0	off peninsula
Area 3	0	0	0	Plymouth, NC
Area 4	0	0	0	off peninsula

Assumptions:
All peat products from Areas 1 + 3 are transported by pipeline to Plymouth, NC and all peat from Areas 2 + 4 is transported to industries off the peninsula via barge on the IWW (from barge terminals adjacent to the mining sites)

5.2.3.5 Water Management

5.2.3.5.1 Acreage of Sediment, Evaporation, and Other Temporary Ponds and Acreage of Permanent Lakes

	1-10	11-20
Area 1	5,000 (temp)	2,900 (perm)
Area 2	0	0
Area 3	0	0
Area 4	1,954 (perm)	4,280 (perm)

Assumptions:

All drainage water from Area 2 is discharged into IWW/ no holding ponds
Area 1: 2 x Scenario #1
Area 3: no holding ponds: sheet flow through wetlands utilized
Area 4: reclamation is open water

5.2.3.5.2 Groundwater Withdrawn from the Quarternary Shell Hash Unit, Yorktown Formation, or Castle Hayne Aquifer for Processing

	at 10	at 20
Area 1	3.7 mgd	10.9 mgd
Area 2	none	none
Area 3	2.2 mgd	8 mgd
Area 4	none	none

Assumptions:

At year 10:
  Area 1: methanol production 160% x Scenario #1 (Area 1)
  Area 3: methanol production 95% x Scenario #1 (Area 1)
At year 20:
  Area 1: methanol production 472% x Scenario #1 (Area 1)
  Area 3: methanol production 351% x Scenario #1 (Area 1)

5.2.3.5.3 Maximum Water Withdrawn from the Surficial Aquifer During Plant Site Preparation

Area 1	3 mgd	(for a period of ten years)
Area 2	0 mgd	
Area 3	3 mgd	(for a period of ten years)
Area 4	0 mgd	

Assumptions:
Methanol plants under construction or expansion during years 1-10 in Areas 1 and 3

5.2.3.5.4 Water Balances for All Mining Sites

Condition	Total Runoff mgy/2000 acres	Subsurface Drainage (in^3/in^2)	Surface Runoff (in^3/in^2)	Evapotranspiration (in^3/in^2)
Pre-mining (disturbed)	1046	11.2	8.0	29.2
Pre-mining (shrub)	788	11.1	3.4	33.9
During mining	1336	6.5	18.0	
After mining (agriculture-330' spaced drainage ditches)	808	6.8	8.0	33.6

Note:
Data based on 15 year averages of computer simulations using weather data from Elizabeth City weather station. Annual average rainfall for the 15 years used was 48.4 inches.

Source:
R. Broadhead, Dept. Biol. and Agric. Eng., NCSU

5.2.3.5.5 Mined and Reclaimed Acreage from Which Drainage Water is Being Pumped During Mining (Cumulative)

	0-5	5-10	10-15	15-20
Area 1	3,000	7,500	16,500	30,000
Area 2	1,500	3,750	8,250	15,000
Area 3	1,500	5,500	13,500	26,000
Area 4	1,500	1,900	3,850	5,750
Total	7,500	18,650	42,100	76,750

Assumptions:

All disturbed acreage requires pumping during mining (i.e., drainage water from all lands gravity drains to lowest points on the mining sites and is pumped into lakes or canals)

Acreage figures do not include unmined land which may drain into the low points depending on its location relative to the sites being mined

Area 4 reclamation is primarily open water, so pumping is not required after mining ends.

Area 1,2 + 3 reclamation is primarily agriculture, so pumping is required after mining ends.

5.2.3.5.6 Maximum Changes in Surficial Groundwater Levels Due to Mining Operations in the Immediate Vicinity of the Mine Site

All areas:

Groundwater levels will decline in the immediate vicinity of the mine by the depth of peat mined. If vegetation is replanted, groundwater level will drop an additional foot.

Source:

R. Broadhead, Dept. Biol. and Agric. Eng., NCSU

5.2.3.5.7 Drainage and Runoff Waters from All Mined and Reclaimed Lands: Direction of Flow/Receiving Body of Water

	1-10	11-20
Area 1	all runoff to temporary lagoons to Canal B to Pungo River	all runoff drains by gravity to a point near the central lake (pumped into lake) from which it is discharged into Canal B to Pungo River
Area 2	mine site to IWW	same as 1-10
Area 3	mine site through wetlands to tributaries of the Alligator River	same as 1-10
Area 4	all runoff into permanent lakes	same as 1-10

Assumptions:

Drainage systems on all mined lands similar to agricultural drainage systems in use throughout the coastal area of NC

Capacity of Canal B is increased to handle greater flows

5.2.3.5.8 Quality of Runoff from All Mining Sites (Areas 1, 2, 3, and 4)

see section 5.2.2.5.8

5.2.3.5.9 Wastewater Treatment: Source/Rate/Route of Effluent Discharge/Receiving Body of Water at Years 10 and 20

	Source	Average Daily Discharge (mgd)		Route	Receiving Body
		at 10	at 20		
Area 1	Methanol plant	1.4	4.1	Canal B or other canals	Pungo R.
Area 2	none				
Area 3	Methanol plant	0.8	3.1	Wetlands	Alligator R. tributaries
Area 4	none				

Assumptions:

Same as section 5.2.3.5.2

5.2.3.5.10 Flood Gates/Flood Control Measures

Area 1

No flood gates constructed beause of elevation

Areas 2, 3 and 4

Flood gates constructed at all drainage outlets from mining sites to permit site drainage but prevent entry of water from water bodies receiving drainage

5.2.3.5.11 Elevation of Dikes Around Mined Areas/Storage Ponds and Lakes

	at 10	at 20
Area 1	20' MSL around temp ponds	20' MSL around central lake
Area 2	dikes and flood gates built at elevation of 100-yr storm	
Area 3	same as Area 2	
Area 4	same as Area 2	

5.2.3.5.12 Probability of Hurricane Flooding in 50- and 100-year Floodplains (at Years 10 and 20)

Area 1

Not susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year

Area 2

Approximately 50% susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year (without protective barriers)

Area 3

Approximately 75% susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year (without protective barriers)

Area 4

100% susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year (without protective barriers)

Source:

Figure 5D

5.2.3.5.13 Change in Groundwater Recharge Rate to the Castle Hayne Aquifer Resulting from Land Clearing and Mining Activities. Values are Average Changes in Recharge Rates Over the Entire Acreage for Each Area.

	1-10	11-20	Over 20 yrs
Area 1	-0.0005 in/yr (-4.8%) -1050 gpd	-0.0004 in/yr -950 gpd	-0.0009 in/yr (-9.2%) -2000 gpd
Area 2	-0.0005 in/yr (-4.8%) -530 gpd	-0.0004 in/yr -470 gpd	-0.0009 in/yr (-9.2%) -1000 gpd
Area 3	-0.0005 in/yr (-4.8%) -910 gpd	-0.0004 in/yr -840 gpd	-0.0009 in/yr (-9.2%) -1750 gpd
Area 4	-0.0005 in/yr (-4.8%) -950 gpd	-0.0004 in/yr -870 gpd	-0.0009 in/yr (-9.2%) -1820 gpd

Notes:

Rate at year 0 = 0.01 in/yr

Change in rate is noted in parentheses

Assumptions:

Assumes layers are isolated laterally (i.e., essentially a vertical system)

Stratigraphy for all areas similar to that found for First Colony Farms (Scenario #1/Area 1)

Depth of mining operations for all areas similar to that proposed by PMA (Scenario #1/Area 1)

Sources:

Foutz, 1983

Calculations by R. Broadhead, Dept. Biol. and Agric. Eng., NCSU

5.2.3.5.14 Salt Water Encroachment in Shallow and Deep Aquifers

Area 1

Impact laterally insignificant in Castle Hayne, Tertiary Sand Aquifer (including the Yorktown Formation), and the Quarternary Shell Hash Unit. Greatest effect will occur if water pumped from the Castle Hayne Aquifer, in which case an upconing or upwelling of brackish water may occur at production wells. Localized effect causing at most an increase in chloride concentrations of a few mg/l.

Area 2

No significant lateral movement in the freshwater/saltwater interface. (No pumping from deeper aquifers for processing water or plant site dewatering.)

Area 3

Impact laterally insignificant in Castle Hayne, Tertiary Sand Aquifer (including the Yorktown Formation), and the Quarternary Shell Hash Unit. Castle Hayne Aquifer is brackish in this area. Greatest effect will occur if water pumped from Yorktown or Tertiary Sand Aquifers, in which case an upconing or upwelling of brackish water may occur at production wells. Localized effect causing at most an increase in chloride concentrations of a few mg/l.

Area 4

No significant lateral movement in the freshwater/saltwater interface. (No pumping from deeper aquifers for processing water or plant site dewatering.)

Source:

B. Jeter, Groundwater Section, DEM, NRCD

5.2.3.5.15 Revegetation of Canal/Ditch Banks

Revegetation is completed following ditch maintenance and as part of reclamation

5.2.3.5.16 Erosion and Sediment Control Measures

Adequate mechanical barriers including but not limited to diversions, settling ponds, earthen dikes, brush barriers, silt check dams, silt retarding structures, rip rap pits or ditches are provided in the initial stages of any land disturbance to prevent sediment from discharging onto any adjacent surface areas or into any lake or natural watercourse in proximity to the affected land.

5.2.3.5.17 Buffer Strips Adjacent to Estuaries/Lakes/Rivers at Years 10 and 20

Area 1	2000' tree buffer between site and Phelps Lake
	1/2 mile between site and Alligator (New) Lake
Area 2	300' between site and IWW
Area 3	1/2 mile between site and Alligator (New) Lake
Area 4	1/2 mile between site and Alligator R.
	300' between site and IWW

Note:
2000' tree buffer is Area 1 outside permitted area
Assumption:
1/2 mile buffer between mining sites and Alligator River is required in mining permits

5.2.3.6 Air Quality Management

5.2.3.6.1 Off-property Fugitive Dust Concentrations Resulting from Mining and Processing Operations at Years 10 and 20

Assuming adequate buffer strips and appropriate spacing of methanol plants (as determined necessary by computer simulation), mining should not cause air quality standards to be exceeded.

Note:
State air quality standards (Increments)
Annual Standard for Particulate (Class I) - 5 $\mu g/M^3$
24-Hour Standard for Particulate (Class I) - 10 $\mu g/M^3$
Annual Standard for Particulate (Class II) - 19 $\mu g/M^3$
24-Hour Standard for Particulate (Class II) - 37 $\mu g/M^3$
Class I - protected areas having air cleaner than the National Ambient Standard (Swanquarter National Wildlife Refuge is the only Class I area on the Albemarle-Pamlico Peninsula)
Class II - other areas having air cleaner than the National Ambient Standard
$\mu g/M^3$ = micrograms per cubic meter
Source:
M. Sewell, Air Quality Section, DEM, NRCD

5.2.3.6.2 Mitigation Measures for Fugitive Dust Emissions During the 20-year Period for All Areas:

restricted speed limits
paving or watering of roadways
tree buffer strips

5.2.3.7 Solid Waste Management

5.2.3.7.1 Amount of Non-hazardous Waste Generated

	1-10	11-20
Area 1	84,800 tons/yr (1.4 million ft^3/yr)	250,160 tons/yr (4 million ft^3/yr)
Area 2	negligible	same as 1-10
Area 3	50,350 tons/yr (0.8 million ft^3/yr)	186,000 tons/yr (3 million ft^3/yr)
Area 4	negligible	same as 1-10

Note:
Waste consists of non-burnable material from methanol production approximately half of which is slag and fly ash

Assumptions:
All figures in ft^3 based on an assumed bulk density of 0.062 tons/ft^3
Same as section 5.2.3.5.2
No significant amount of non-hazardous waste generated in Areas 2 and 4

5.2.3.7.2 Amount of Hazardous Waste Generated

	1-10	11-20
Area 1	1,600 ft^3/yr	4,720 ft^3/yr
Area 2	none	none
Area 3	950 ft^3/yr	3,510 ft^3/yr
Area 4	none	none

Assumptions:
No hazardous wastes generated in Areas 2 + 4 since no peat will be processed on site
Same as section 5.2.3.5.2
Excludes catalysts recycled and waste oils (amount unknown)

5.2.3.8 Wildlife Mitigation Measures

5.2.3.8.1 Permitted Acreage Restored to Native Vegetation (Buffer Strips)

See section 5.2.3.10.6

Assumption:
20% mined/reclaimed land required re-established to native vegetation or low intensity managed forest for buffer strips

Source:
D. Owens, Office of Coastal Management, NRCD

5.2.3.8.2 Location of Native Vegetation Buffer Strips on Permitted Areas at Years 10 and 20

see Figure 5E

5.2.3.9 Fire Protection Measures

5.2.3.9.1 Source and Volume of Water for Fire Suppression

	1-10	11-20
Area 1	Canals, lagoons- 28 unharvested blocks in use as water storage reservoirs	Central lake (2900 ac)
Area 2	Fire protection/waterfowl impoundment	same as at 10
Area 3	same as Area 1	same as Area 3 (1-10)
Area 4	Reclaimed lakes	same as 1-10

5.2.3.9.2 Water Control Structures for Areas Not Being Mined

Structures installed to prevent gravity drainage from lowering water level lower than 1' below ground level on lands not being actively mined. These structures have capacity to retain sufficient water to flood or saturate peat soil to or slightly above ground level.

5.2.3.10 Reclamation

5.2.3.10.1 Mined Acreage Legally Required to be Reclaimed (Cumulative)

	by 10	by 20
Area 1	5,700	24,600
Area 2	2,850	12,300
Area 3	3,900	21,000
Area 4	2,640	10,700
Total	15,090	68,600

Assumptions:

NRCD requirement that mined areas be reclaimed within 2 years of completion of mining is met

All legally reclaimable land reclaimed on schedule (refers to sections 5.2.3.10.3-5.2.3.10.8)

Source:

Figure 5F

5.2.3.10.2 Percentage of Reclaimed Land in Various Types of Reclamation (Cumulative)

	Area 1		Area 2	Area 3	Area 4	
	by 10	by 20	by 10+20	by 10+20	by 10	by 20
Row crops with pumping	24	63	78	75	0	0
Row crops without pumping	0	0	0	0	0	0
Pine plantations	10	10	10	10	10	18
Restored native veg.	10	10	10	10	10	18
Open water	51	12	0	0	74	40
Grass replanted	5	5	2	5	2	2
Residential areas	0	0	0	0	4	22

Assumptions:

Native vegetation restored in buffer strips as shown in Figure 5E

Pumping in all reclaimed lands is required

5.2.3.10.3 Mined Acreage in Row Crops with Pumping (Cumulative)

	by 10	by 20
Area 1	1,368	15,543
Area 2	2,223	9,594
Area 3	2,925	15,750
Area 4	0	0
Total	6,516	40,887

Calculations:
Sections 5.2.3.10.3-5.2.3.10.8 calculated based on % in section 5.2.3.10.2 and acreages in section 5.2.3.10.1

5.2.3.10.4 Mined Acreage in Row Crops Without Pumping (Cumulative)

	by 10	by 20
Area 1	0	0
Area 2	0	0
Area 3	0	0
Area 4	0	0
Total	0	0

5.2.3.10.5 Mined Acreage in Pine Plantations (Including Vegetative Buffer Strips) (Cumulative)

	by 10	by 20
Area 1	570	2,460
Area 2	285	1,230
Area 3	390	2,100
Area 4	264	1,926
Total	1,509	7,716

5.2.3.10.6 Mined Acreage Restored to Native Vegetation (Buffer Strips) (Cumulative)

	by 10	by 20
Area 1	570	2,460
Area 2	285	1,230
Area 3	390	2,100
Area 4	264	1,926
Total	1,509	7,716

5.2.3.10.7 Mined Acreage in Open Water Reclamation With/Without Marshes and Islands (Including Canals) (Cumulative)

	by 10	by 20
Area 1	2,907	2,907
Area 2	0	0
Area 3	0	0
Area 4	1,954	4,280
Total	4,861	7,187

5.2.3.10.8 Mined Areas Replanted to Grass (Cumulative)

	by 10	by 20
Area 1	285	1,230
Area 2	57	246
Area 3	195	1,050
Area 4	53	214
Total	590	2,740

5.2.3.10.9 Mined Acreage Reclaimed as Residential Areas (Cumulative)

	by 10	by 20
Area 1	0	0
Area 2	0	0
Area 3	0	0
Area 4	106	2,354
Total	106	2,354

5.2.3.10.10 Unreclaimed Mined Acreage Not Yet Legally Required to be Reclaimed (Cumulative)

	by 10	by 20
Area 1	1,800	5,400
Area 2	900	2,700
Area 3	1,600	5,000
Area 4	760	2,300
Total	5,060	15,400

Source:
Figure 5F

5.2.3.10.11 Unreclaimed Mined Acreage Legally Required to be Reclaimed (Cumulative)

	by 10	by 20
Area 1	0	0
Area 2	0	0
Area 3	0	0
Area 4	0	0
Total	0	0

Assumption:
All legally reclaimable acreage reclaimed on schedule

5.2.4 Scenario #3: Industry Failure

(Static: at years 1/10/20 and/or Cumulative: years 1-10 and 11-20)

Note:
PMA documents refer only to 15,012 acres assumed permitted for methanol production (Area 1) and not to horticultural operations.

5.2.4.1 Permitted Mining Activity

5.2.4.1.1 Permitted Acreage

	year 1	10	20
Area 1	15,818		
Area 2	7,142		
Total	22,960		

Assumptions:
- No further acreage is permitted during the next 20 years.
- Permit renewals are granted for continuation of mining on already permitted acreage
- First Colony Farms' mining permit is transferred to PMA

Sources:
- Mining Permits

5.2.4.1.2 Location of Permitted Acreage

same as section 5.2.2 (see Figure 5B)

5.2.4.2 Land Disturbance

5.2.4.2.1 Acreage Mined (Cumulative)

	by 10	by 20
Area 1	5520	5520
Area 2	3000	3000
Total	8520	8520

Assumptions:
- Mining start dates and rates occur as indicated in Figure 5H
- Disturbed acreages: Area 2 and Area 1 (horticultural operations)
- All mining operations fail at year 10

Source: Figure 5H

Figure 5H: Scenario #3-- Acreage disturbed

	Year 1 2 3 4 5	 6 7 8 9 10	 11 12 13 14 15	 16 17 18 19 20	Total
Area 1 Permitted: 15,818 ac. Mined: 5,520 ac.	3,080	2,440	0	0	5,520 ac.
Area 2 Permitted: 7,142 ac. Mined: 3,000 ac.	1,500	1,500	0	0	3,000 ac.
Maximum Acreage Disturbed	8,520		0		8,520 ac.

5.2.4.2.2 Average Acreage in Peat Mining Production at Any One Time

	1-10	11-20
Area 1	2000	0
Area 2	1500	0
Total	3500	0

Source:
Section 5.2.2.2.2

5.2.4.2.3 Maximum Acreage Disturbed (in Preparation or Being Mined) at Any One Time

	at 10	at 20
Area 1	2880	0
Area 2	1800	0
Total	4680	0

Source:
Section 5.2.2.2.3

5.2.4.2.4 Average Annual Rate of Land Disturbance

	1-10
Area 1	552
Area 2	300

Assumptions:
Mining rates
Years 11-20: no mining

5.2.4.2.5 Elevation of Mined Acreage

	Land Elev. (MSL)	Expected Max. Mine Depth	Average Depth of Mining	Minimum Elev of Mined Acreage (MSL)
Area 1	13-18'	9'	4-5'	7-12'
Area 2	5-10'	9'	4-5'	1'

Sources:
Elevations - see Figure 5C
Mining Permit Applications and Permits

5.2.4.2.6 Undisturbed Permitted Acreage at Years 10 and 20

Area 1	10,298
Area 2	4,142 (includes a 410 acre conservation easement-to remain unmined)
Total	14,440

5.2.4.3 Mining and Processing Technologies

5.2.4.3.1 Mining Technologies in Use

Area 1
- Milled peat production (15,012 acres permitted)
- Bulldozer, truck, and front-end loader (98 acres permitted)
- Scrape mining (similar to milled method) (708 acres permitted)

Area 2
- Milled peat production (7,142 acres permitted)

Sources:
Mining Permit Applications

5.2.4.3.2 Average Amount of Peat Mined Per Year (at Year 10)

Area 1	525,000 dry tons	(875,000 tons at 40% moisture)
Area 2	140,000 dry tons	(235,000 tons at 40% moisture)
Total	665,000 dry tons	(1,110,000 tons at 40% moisture)

Assumptions:
140 mining days per year (average)
Amount of peat mined is based on:
  Area 1- 3,600 dry tons/day x (average) 140 mining days - peat for methanol production
  25,000 dry tons/year - horticultural peat
  Area 2- 1,000 dry tons/day x (average) 140 mining days
At Year 20: no mining ongoing

Source:
Section 5.2.2.3.2

5.2.4.3.3 Processing Technologies in Use at Year 10

Area 1
Conversion to methanol (500,000 dry tons per year)
Export as horticultural peat (25,000 dry tons per year)

Area 2
Export to industry as peat for fuel (140,000 dry tons per year)

Assumption:
At 20: no processing ongoing
Sources:
Mining Permit Applications

5.2.4.3.4 Products from Mined Peat: Type and Amount

	at 10
Area 1	
methanol	60 million gals/year
horticultural peat	25,000 dry tons/year
Area 2	
peat for industrial use (fuel)	140,000 dry tons/year

Assumptions:
Area 1: methanol plant annual output equivalent to approximately 310 days per year at full capacity requiring an average of 1,600 dry tons peat per day to produce an average of 200,000 gallons of methanol per day
Area 2: peat for industrial use (fuel) is mined/produced 140 days per year
At Year 20: none

5.2.4.4 Transportation

5.2.4.4.1 Type and Maximum Volume of Transportation to and on Site (Construction and Operation)

	Type	Size	Number/day
Area 1	heavy duty trucks	up to 36 tons	40 (construction) 13 (operation)
Area 2	trucks	up to 36 tons	5 (operation)

Assumptions:
Years 1-3: construction ongoing in Area 1
Years 4-20: no construction ongoing in Area 1
No construction required in Area 2
Years 11-20: no mining operation ongoing
Operation traffic excludes transportation of peat or peat products. Refers in Area 1 primarily to transportation of slag and fly ash.

Source:
PMA, 1983j, p. 25 and Fig. 4-2

5.2.4.4.2 Type and Volume of Transportation on Site - Harvesting

1-10

	Type	Volume
Area 1	tractor & carts (15-ton capacity)	233 loads/day to methanol plant storage pile or shipping area for horticultural peat
Area 2	tractor and carts (15-ton capacity)	63 loads/day to shipping area

Assumptions:
Assumes peat can be transported from mining site to processing plant or shipping area 250 days/year
Years 11-20: no harvesting

Calculations (1-10):
Area 1: 875,000 tons of peat (at 40% moisture) per year/15 tons per cart/250 days per year
Area 2: 235,000 tons of peat (at 40% moisture) per year/15 tons per cart/ 250 days per year

Source:
PMA, 1983i, p. 22 states that peat can be transported from the mining site to the plant stockpile approximately 251 days per year

5.2.4.4.3 Type, Volume, and Route of Transportation from Site - Products

	Number	Type	at 10 Size	Route
Area 1	27/day	trucks	36-ton	Rte 64 to Plymouth, NC
Area 2	2/week	barges	1,500-ton	IWW (south)

Assumptions:
Peat from Area 2 is transported via barge through the IWW to a major industry off the peninsula (50 weeks per year)
Horticultural peat and methanol from Area 1 transported to barge and RR facilities in Plymouth, NC
At year 20: no products being transported
Source:
PMA, 1983j, pp. 44 & 73

5.2.4.4.4 Maximum Distance (Miles) Peat Transported on Unpaved Roads on Site

	1-10
Area 1	2.5
Area 2	4

Assumptions:
Years 11-20: no peat being mined or transported
Distances for Area 2
Source:
PMA, 1983d, Fig. 4-1

5.2.4.4.5 Distance Products Transported on Paved/Unpaved Roads from Site (Miles)

1-10

	paved	unpaved	total	destination
Area 1	19	10	29 (one way)	Plymouth, NC
Area 2	0	0	0	

Assumptions:
All peat products from Area 1 are transported to or through Plymouth, NC and all peat from Area 2 is transported to a major industry off the peninsula via barge on the IWW (from a barge terminal adjacent to the mining site)
Area 1: assumes road north of site remains unpaved
Years 11-20: no products being transported
Sources:
PMA, 1983j

5.2.4.5 Water Management

5.2.4.5.1 Acreage of Sediment, Evaporation, and Other Temporary Ponds and Acreage of Permanent Lakes

	1-9	10-20
Area 1	2550 (temporary) (maximum depth 3')	1450 (permanent (maximum depth 8')
Area 2	0	0

Assumptions:
All drainage water from Area 2 is discharged into IWW (no holding ponds)
At year 10 all pumping ceases
Sources:
PMA, 1983d and 1983i, p. 91 (size of temp and perm ponds)

5.2.4.5.2 Groundwater Withdrawn from the Quarternary Shell Hash Unit for Processing at Year 10

Area 1	2.3 mgd
Area 2	none

Assumptions:
Withdrawals made from the Quarternary Shell Hash Unit (underlying Area 1 at depths of 40 to 130 feet)
At year 20: no withdrawals being made
Sources:
Section 5.2.2.5.2

5.2.4.5.3 Maximum Water Drained from the Surficial Aquifer During Plant Site Preparation

Area 1	3 mgd (for a period of two years)
Area 2	0 mgd

Assumption:
No plant constructed in Area 2
Sources:
PMA Water Use Permit Applications and Permits

5.2.4.5.4 Water Balances for Mining Sites (Until Cessation of Pumping)

Condition	Total Runoff mgy/2000 acres (Area 1)	Total Runoff mgy/1500 acres (Area 2)	Subsurface Drainage (in^3/in^2)	Surface Runoff (in^3/in^2)	Evapo-trans-piration (in^3/in^2)
Pre-mining (disturbed)	1046	784	11.2	8.0	29.2
Pre-mining (shrub)	788	591	11.1	3.4	33.9
During mining	1336	1002	6.5	18.0	
After mining (agriculture-330' spaced drainage ditches)	808	606	6.8	8.0	33.6

Notes:

Data based on 15 year averages of computer simulations using weather data from Elizabeth City weather station. Annual average rainfall for the 15 years used is 48.4''.

Source:

R. Broadhead, Dept. Biol. and Agric. Eng., NCSU

5.2.4.5.5 Mined and Reclaimed Acreage from Which Drainage Water is Being Pumped During Mining (Cumulative)

	0-5	5-10	10-15	15-20
Area 1	3080	5520	0	0
Area 2	1500	3000	0	0
Total	4580	8520	0	0

Assumptions:

All disturbed acreage requires pumping during mining (i.e., drainage water from all lands gravity drains to lowest points on the mining sites and is pumped into lakes or canals)

Acreage figures do not include unmined land which may drain into the low points depending on the location of unmined lands relative to the sites being mined

All pumping ceases at year 10

Sources:

L. Otte, Geol. Dept., ECU

R. Broadhead, Dept. Biol. and Agric. Eng., NCSU

5.2.4.5.6 Maximum Changes in Surficial Groundwater Levels at the Mine Sites

Areas 1 and 2
Groundwater levels will decline in areas where peat is removed by the depth of peat mined. If vegetation is replanted, groundwater level will drop an additional foot.

Source: R. Broadhead, Dept. Biol. and Agric. Eng., NCSU

Area 1
Projected maximum effects of mining operations on water levels along the northern edge of the site are a decline of about 3.5' in the Fine Sand Unit and 2.5' in the Shell Hash Unit.

Note:
Surficial groundwater levels will return to pre-mining conditions following failure of the industry and cessation of pumping
Source:
PMA, 1983k, p. 84

5.2.4.5.7 Drainage and Runoff Waters from All Mined and Reclaimed Lands: Direction of Flow/Receiving Body of Water

	1-10	after year 10
Area 1	all runoff to temp. lagoons or central lake to Canal B to Pungo River (mean annual discharge from holding ponds: 8cfs/ max runoff: 59.6 cfs)	all runoff to Canal B to Pungo River
Area 2	mine site to IWW	same as 1-10

Assumptions:
Drainage systems on all mined lands similar to agricultural drainage systems in use throughout the coastal area of NC

5.2.4.5.8 Quality of Runoff from All Mining Sites (Areas 1 and 2)

see section 5.2.2.5.8

5.2.4.5.9 Wastewater Treatment: Source/Rate/Route of Effluent Discharge/Receiving Body of Water at Year 10

	Source	Average Daily Discharge	Route	Receiving Body
Area 1	Methanol plant	870,000 gal/day	Canal B	Pungo R.
Area 2	none			

Assumption:
No processing occurs on mining site in Area 2
At year 20: none
Source:
PMA, 1983i

5.2.4.5.10 Flood Gates/Flood Control Measures

Area 1
No flood gates constructed because of elevation

Area 2
Flood gates constructed at all drainage outlets from mining sites to permit site drainage but prevent entry of water from IWW. Flood gates not operational after industry fails.

Source:
Section 5.2.2.5.10

5.2.4.5.11 Elevation of Dikes Around Mined Areas/Storage Ponds and Lakes

	at 10	at 20
Area 1	20' MSL	20' MSL
Area 2	no dikes	no dikes

5.2.4.5.12 Probability of Hurricane Flooding in 100-year Floodplain (at Years 10 and 20)

Area 1
Not susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year

Area 2
About 50% susceptible to flood inundation caused by wind tides having a 1% chance of being equalled or exceeded in any one year (without protective barriers)

Source:
Figure 5D

5.2.4.5.13 Change in Groundwater Recharge Rate to the Castle Hayne Aquifer Resulting from Land Clearing and Mining Activities. Values are Average Changes in Recharge Rates Over the Entire Acreage for Each Area

	1-10	11-20
Area 1	-0.0005 in/yr (-5.2%) -600 gpd	0
Area 2	-0.0007 in/yr (-7.6%) -400 gpd	0

Notes:

Rate at year 0 = 0.01

Change in rate is noted in parentheses

Assumptions:

Assumes layers are isolated laterally (i.e., essentially a vertical system)

Stratigraphy for all areas similar to that found for First Colony Farms (Area 1)

Depth of mining operations for all areas similar to that proposed by PMA (Area 1)

Source:

Foutz, 1983.

5.2.4.5.14 Salt Water Encroachment in Shallow and Deep Aquifers

Areas 1 and 2

No significant lateral movement in the freshwater/saltwater interface. Since there is already a wide diffused zone ranging from salt to fresh water, the anticipated change in head due to withdrawals (a few feet) is not expected to significantly change the location of this diffused zone

Sources:

Perry Nelson, Groundwater Section, DEM, NRCD

PMA, 1983k

5.2.4.5.15 Revegetation of Canal/Ditch Banks

Revegetation is completed following ditch maintenance and as part of reclamation through year 8

5.2.4.5.16 Erosion and Sediment Control Measures

Adequate mechanical barriers including but not limited to diversions, settling ponds, earthen dikes, brush barriers, silt check dams, silt retarding structures, rip rap pits or ditches provided in the initial stages of any land disturbance to prevent sediment from discharging onto any adjacent surface areas or into any lake or natural watercourse in proximity to the affected land. Following industry failure no structures are maintained.

5.2.4.5.17 Buffer Strips Adjacent to Estuaries/Lakes/Rivers at Years 10 and 20

Area 1	2000' tree buffer between site and Phelps Lake
Area 2	300' between site and IWW

Note:
2000' tree buffer in Area 1 is outside permitted area
Sources:
PMA, 1983f
WTF Mining Permit

5.2.4.6 Air Quality Management

5.2.4.6.1 Maximum Off-property Fugitive Dust Concentrations Resulting from Mining and Processing Operations

at Year 10: same as section 5.2.2.6.1

at Year 20: none

5.2.4.6.2 Mitigation Measures for Fugitive Dust Emissions from Transportation of Peat in Use

1-10

Area 1
- restricted speed limits
- paving or watering of roadways
- tree buffer strips

Area 2
- restricted speed limits
- tree buffer strips

Assumptions:
All of the above
Years 11-20: no mining

5.2.4.7 Solid Waste Management

5.2.4.7.1 Amount of Non-hazardous Waste Generated

1-10

Area 1 53,000 tons/yr (851,000 ft^3/yr*)
(non-burnable material from methanol production, including 27,000 tons/yr of slag and fly ash)

Area 2 negligible

Assumptions:
* Assumes a bulk density of 0.062 tons/ft^3
No significant amount of non-hazardous waste generated in Area 2
Years 11-20: none generated
Source:
PMA, 1983h, Fig. 1

5.2.4.7.2 Amount of Hazardous Waste Generated

1-10

Area 1 1,000 ft^3/yr (excluding catalysts recycled)
8,100 gals/yr waste oils

Area 2 none

Assumptions:
No hazardous wastes generated in Area 2 since no peat will be processed on site
Years 11-20: none generated
Source:
PMA, 1983h

5.2.4.8 Wildlife Mitigation Measures

5.2.4.8.1 Permitted Acreage Restored to Native Vegetation (Buffer Strips)

See section 5.2.4.10.6

Assumption:
20% mined/reclaimed land required re-established to native vegetation or low intensity managed forest for buffer strips
Source:
D. Owens, Office of Coastal Management, NRCD

5.2.4.8.2 Location of Native Vegetation Buffer Strips on Permitted Areas at Year 10

see Figure 5E

5.2.4.9 Fire Protection Measures

5.2.4.9.1 Source and Volume of Water for Fire Suppression

	1-10
Area 1	Canals, lagoons- 14 unharvested blocks in use as water storage reservoirs
Area 2	Fire protection/waterfowl impoundment

Assumption:
Years 11-20: Areas will be flooded following cessation of pumping
Source:
PMA, 1983c, pp. 13, 37

5.2.4.9.2 Water Control Structures for Areas Not Being Mined

Structures installed to prevent gravity drainage from lowering water level lower than 1' below ground level on lands not being actively mined. These structures have capacity to retain sufficient water to flood or saturate peat soil to or slightly above ground level. Structures not functional after year 10.

Assumptions:
All of the above

5.2.4.10 Reclamation

5.2.4.10.1 Mined Acreage Legally Required to be Reclaimed (Cumulative)

	by 10	by 20
Area 1	2,020	5,520
Area 2	1,500	3,000
Total	3,520	8,520

Assumptions:

NRCD requirement that mined areas be reclaimed within 2 years of completion of mining is met

Land mined during years 1-8 reclaimed on schedule (refers to sections 5.2.4.10.3-5.2.4.10.8)

No land is reclaimed after year 8

Reclamation rate for Area 2

Land fully reclaimed (cumulative):

	by 10	by 20
Area 1	2,020	2,020
Area 2	1,500	1,500

Source:

PMA, 1983d, Fig. 2-10

5.2.4.10.2 Percentage of Reclaimed Land in Various Types of Reclamation by Year 10

	Area 1	Area 2
Row crops with pumping	8	78
Row crops without pumping	0	0
Pine plantations	10	10
Restored native vegetation	10	10
Open water	72	0
Grass replanted	0	2

Assumptions:

Native vegetation restored in buffer strips as shown in Figure 5E

Pumping required for all reclaimed farmland

When pumping ceases, dikes around the central lake are broken, Canal B is no longer maintained, and mined areas in Area 1 gradually fill up with water until, by year 20, all mined acreage (5,520) has become open water. Area 2 also becomes open water by year 20 (3,000 acres).

5.2.4.10.3 Mined Acreage in Row Crops with Pumping

	by 10
Area 1	162
Area 2	1,170
Total	1,332

Calculations:
Sections 5.2.4.10.3-5.2.4.10.8 calculated based on % in section 5.2.4.10.2 and acreages in section 5.2.4.10.1

5.2.4.10.4 Mined Acreage in Row Crops Without Pumping

	by 10
Area 1	0
Area 2	0
Total	0

5.2.4.10.5 Mined Acreage in Pine Plantations (Including Vegetative Buffer Strips)

	by 10
Area 1	202
Area 2	150
Total	352

5.2.4.10.6 Mined Acreage Restored to Native Vegetation (Buffer Strips)

	by 10
Area 1	202
Area 2	150
Total	352

5.2.4.10.7 Mined Acreage in Open Water Reclamation With/Without Marshes and Islands (Including Canals)

	by 10
Area 1	1,454
Area 2	0
Total	1,454

5.2.4.10.8 Mined Acreage Replanted to Grass

	by 10
Area 1	0
Area 2	30
Total	30

5.2.4.10.9 Unreclaimed Disturbed Acreage Not Yet Legally Required to be Reclaimed (Cumulative)

	by 10	by 20
Area 1	3,500	0
Area 2	1,500	0
Total	5,000	0

Source:
Section 5.2.2.10.9

5.2.4.10.10 Unreclaimed Disturbed Acreage Legally Required to be Reclaimed (Cumulative)

	by 10	by 20
Area 1	0	3,500
Area 2	0	1,500
Total	0	5,000

Assumption:
All legally reclaimable land reclaimed on schedule only through year 8

6. ENVIRONMENTAL AND ECONOMIC ASSESSMENT OF THE SCENARIOS

6.1 Resource Production/Consumption

6.1.1 Agriculture

6.1.1.1 Approach/Assumptions

Two approaches to estimating the value of agricultural production under the alternative scenarios were taken: 1) the value of mined land reclaimed to agriculture was estimated at years 10 and 20 (see section 6.1.1.1.1) and 2) the cumulative value of total agricultural production on permitted sites (reclaimed areas in row crops plus acreage already in agricultural production prior to mining and not yet mined) was estimated for the periods years 1-10 and 1-20 (see section 6.1.1.1.2).

An important difference in the two approaches was that the assumption was made in section 6.1.1.1.1 that no acreage was in agricultural production at year 0, while in section 6.1.1.1.2 the assumption was made that part of the total permitted acreage was in agricultural production at year 0 (see acreages by habitat/land use type in Appendix 10.1).

6.1.1.1.1 Value of Mined Land Reclaimed to Row Crops at Years 10 and 20

1. Acreage in agricultural production (row crops) at years 10 and 20 for each scenario was based on sections 5.2.2.10.3, 5.2.3.10.3 and 5.2.4.10.3.

2. Crop mix was assumed to be traditional corn-soybeans rotation on 50% of each area and corn-soybeans-wheat rotation on the other 50%.

3. Budgets were based on standard budget for 1983 produced by Department of Economics and Business, N. C. State University (see Appendix 10.2).

4. Run #1 - Yields assumed: 115 bushels (bu/ac) for corn, 35 bu for soybeans single cropped; 25 bu for soybeans double cropped and 50 bu for wheat were estimated based on yields reported in Soil Survey of Washington County (USDA, SCS, 1981). Prices assumed for Run #1: Corn $2.26/bu, soybeans $5.85/bu and wheat $3.60/bu.

5. Run #2 - Yields assumed: 115 bu for corn, 35 bu for soybeans single cropped, 30 bu for soybeans double cropped and 50 bu for wheat. Prices assumed for Run #2: Corn $2.71/bu, soybeans $6.75/bu and wheat $4.00/bu.

6. Drainage cost was estimated at $10.00/acre/year.

6.1.1.1.2 Cumulative Value of Total Agricultural Production on Permitted Sites During Years 1-10 and 1-20

1. Acreages in agricultural production in all permitted areas at year 0 were based on habitat type/land use data located in Appendix 10.1.

2. Crop mix, Run #1 and #2 assumptions and estimated drainage costs were the same as in section 6.1.1.1.1.

3. Without the mining projects, agricultural production was assumed to remain constant throughout the 20-year period.

4. Conversion rates from one habitat type/land use to another were the same as those used in section 6.1.4 (see Appendix 10.4).

5. A Suitability Index (SI) was determined for each crop by multiplying assumed yield (bu/ac) x price/bu x % of cropland planted with that crop.

6. Annualized units (SI x acres of cropland) for each crop for each year were computed.

7. Cumulative values for the periods years 1-10 and years 1-20 were calculated.

6.1.1.1.2 Data

Table 6.1.1A: Value of mined areas reclaimed to row crops with pumped drainage at years 10 and 20 (Run #1)

Crop	Reclaimed Acres in Row Crops	Total Bushels Per Year	Gross Income Per Year	Net Return to Land and Mgt Per Year
Scenario #1 - Area 1				
1. 162 acres reclaimed to row crops at year 10				
Corn	81	9,315	$ 21,052	$ 3,818
Soybeans	40	1,400	8,190	2
Soybeans-		1,025		
Wheat	41	2,050	13,376	2,271
Total			$ 42,618	$ 6,091
2. 4,930 acres reclaimed to row crops at year 20				
Corn	2,465	283,475	$ 640,654	$ 116,195
Soybeans	1,232	43,120	252,252	62
Soybeans-		30,825		
Wheat	1,233	61,650	402,266	68,297
Total			$ 1,295,172	$ 184,554
Scenario #1 - Area 2				
1. 1,170 acres reclaimed to row crops at year 10				
Corn	585	67,275	$ 152,042	$ 27,576
Soybeans	292	10,220	59,787	15
Soybeans-		7,325		
Wheat	293	14,650	95,591	16,229
Total			$ 307,420	$ 43,820
2. 3,510 acres reclaimed to row crops at year 20				
Corn	1,755	201,825	$ 456,125	$ 82,727
Soybeans	877	30,695	179,566	44
Soybeans-		21,950		
Wheat	878	43,900	286,448	48,633
Total			$ 922,139	$ 131,404

Table 6.1.1A (Continued)

Crop	Reclaimed Acres in Row Crops	Total Bushels Per Year	Gross Income Per Year	Net Return to Land and Mgt Per Year
Scenario #2 - Area 1				
1. 1,368 acres reclaimed to row crops at year 10				
Corn	684	78,660	$ 177,772	$ 32,242
Soybeans	342	11,970	70,025	17
Soybeans-		8,550		
Wheat	342	17,100	111,578	18,944
Total			$ 359,375	$ 51,203
2. 15,543 acres reclaimed to row crops at year 20				
Corn	7,772	893,780	$ 2,019,943	$ 366,357
Soybeans	3,885	135,975	795,454	196
Soybeans-		97,150		
Wheat	3,886	194,300	1,267,808	215,248
Total			$ 4,083,205	$ 581,801
Scenario #2 - Area 2				
1. 2,223 acres reclaimed to row crops at year 10				
Corn	1,112	127,880	$ 289,009	$ 52,418
Soybeans	555	19,425	113,636	28
Soybeans-		13,900		
Wheat	556	27,800	181,395	30,797
Total			$ 584,040	$ 83,243
2. 9,594 acres reclaimed to row crops at year 20				
Corn	4,797	551,655	$ 1,246,740	$ 226,121
Soybeans	2,398	83,930	490,991	121
Soybeans-		59,975		
Wheat	2,399	119,950	782,674	132,882
Total			$ 2,520,405	$ 359,124

Table 6.1.1A (Continued)

Scenario #2 - Area 3

1. 2,925 acres reclaimed to row crops at year 10

Crop	Reclaimed Acres in Row Crops	Total Bushels Per Year	Gross Income Per Year	Net Return to Land and Mgt Per Year
Corn	1,463	168,245	$ 380,234	$ 68,963
Soybeans	731	25,585	149,672	37
Soybeans-		18,275		
Wheat	731	36,550	238,489	40,491
Total			$ 768,395	$ 109,491

2. 15,750 acres reclaimed to row crops at year 20

Crop	Reclaimed Acres in Row Crops	Total Bushels Per Year	Gross Income Per Year	Net Return to Land and Mgt Per Year
Corn	7,875	905,625	$ 2,046,713	$ 371,212
Soybeans	3,938	137,830	806,306	198
Soybeans-		98,425		
Wheat	3,937	196,850	1,284,446	218,073
Total			$ 4,137,465	$ 589,483

Scenario #2 - Area 4

No land in row crops at year 10 or 20.

Scenario #3 (both areas)

Same as Scenario #1 at year 10 in Areas 1 and 2.

Table 6.1.1B: Value of mined areas reclaimed to row crops with pumped drainage at years 10 and 20 (Run #2)

Crop	Reclaimed Acres in Row Crops	Total Bushels Per Year	Gross Income Per Year	Net Return to Land and Mgt Per Year
Scenario #1 - Area 1				
1. 162 acres reclaimed to row crops at year 10				
Corn	81	9,315	$ 25,244	$ 8,010
Soybeans	40	1,400	9,450	1,262
Soybeans-		1,230		
Wheat	41	2,050	16,503	5,397
Total			$ 51,197	$ 14,669
2. 4,930 acres reclaimed to row crops at year 20				
Corn	2,465	283,475	$ 768,217	$ 243,763
Soybeans	1,232	43,120	291,060	38,868
Soybeans-		36,990		
Wheat	1,233	61,650	496,283	162,314
Total			$ 1,555,560	$ 444,945
Scenario #1 - Area 2				
1. 1,170 acres reclaimed to row crops at year 10				
Corn	585	67,275	$ 182,315	$ 57,850
Soybeans	292	10,220	68,985	9,212
Soybeans-		8,790		
Wheat	293	14,650	117,933	38,571
Total			$ 369,233	$ 105,633
2. 3,510 acres reclaimed to row crops at year 20				
Corn	1,755	201,825	$ 546,946	$ 173,551
Soybeans	877	30,695	207,191	27,668
Soybeans-		26,340		
Wheat	878	43,900	353,395	115,581
Total			$ 1,107,532	$ 316,800

Table 6.1.1B (Continued)

Crop	Reclaimed Acres in Row Crops	Total Bushels Per Year	Gross Income Per Year	Net Return to Land and Mgt Per Year
Scenario #2 - Area 1				
1. 1,368 acres reclaimed to row crops at year 10				
Corn	684	78,660	$ 213,169	$ 67,641
Soybeans	342	11,970	80,798	10,790
Soybeans-		10,260		
Wheat	342	17,100	137,655	45,021
Total			$ 413,622	$ 123,452
2. 15,543 acres reclaimed to row crops at year 20				
Corn	7,772	893,780	$ 2,422,144	$ 768,570
Soybeans	3,885	135,975	917,831	122,567
Soybeans-		116,580		
Wheat	3,886	194,300	1,564,115	511,559
Total			$ 4,904,090	$1,402,696
Scenario #2 - Area 2				
1. 2,223 acres reclaimed to row crops at year 10				
Corn	1,112	127,880	$ 346,555	$ 109,965
Soybeans	555	19,425	131,119	17,510
Soybeans-		16,680		
Wheat	556	27,800	223,790	73,193
Total			$ 701,464	$ 200,668
2. 9,594 acres reclaimed to row crops at year 20				
Corn	4,797	551,655	$ 1,494,985	$ 474,374
Soybeans	2,398	83,930	566,528	75,654
Soybeans-		71,970		
Wheat	2,399	119,950	965,598	315,808
Total			$ 3,027,111	$ 865,836

Table 6.1.1B (Continued)

Crop	Reclaimed Acres in Row Crops	Total Bushels Per Year	Gross Income Per Year	Net Return to Land and Mgt Per Year

Scenario #2 - Area 3

1. 2,925 acres reclaimed to row crops at year 10

Crop	Reclaimed Acres in Row Crops	Total Bushels Per Year	Gross Income Per Year	Net Return to Land and Mgt Per Year
Corn	1,463	168,245	$ 455,944	$ 144,676
Soybeans	731	25,585	172,699	23,062
Soybeans-		21,930		
Wheat	731	36,550	294,228	96,230
Total			$ 922,871	$ 263,968

2. 15,758 acres by 20 years

Crop	Reclaimed Acres in Row Crops	Total Bushels Per Year	Gross Income Per Year	Net Return to Land and Mgt Per Year
Corn	7,875	905,625	$ 2,455,244	$ 778,756
Soybeans	3,938	137,830	930,353	124,239
Soybeans-		118,110		
Wheat	3,937	196,850	1,584,643	518,273
Total			$ 4,970,240	$1,421,268

Scenario #2 - Area 4

No land in row crops at year 10 or 20

Scenario #3 (both areas)

Same as Scenario #1 at year 10 in 20

Table 6.1.1C: Summary-- Value of mined areas reclaimed to agriculture with pumped drainage at years 10 and 20 (Run #1)

	Reclaimed Acres in Row Crops	Gross Income Per Year	Net Return to Land and Mgt Per Year	Net Income Minus Drainage Cost
Scenario #1 (both areas)				
At year 10	1,332	$ 350,038	$ 49,911	$ 36,585
At year 20	8,440	2,217,211	315,958	231,597
Scenario #2 (all areas)				
At year 10	6,516	$ 1,711,810	$ 243,937	$ 178,806
At year 20	40,887	10,741,075	1,530,408	1,121,789
Scenario #3 (both areas)				
Same as Scenario #1 at year 10				

Table 6.1.1D: Summary-- Value of mined areas reclaimed to agriculture with pumped drainage at years 10 and 20 (Run #2)

	Reclaimed Acres in Row Crops	Gross Income Per Year	Net Return to Land and Mgt Per Year	Net Income Minus Drainage Cost
Scenario #1 (both areas)				
At year 10	1,332	$ 420,430	$ 120,302	$ 106,948
At year 20	8,440	2,663,092	761,745	677,191
Scenario #2 (all areas)				
At year 10	6,516	$ 2,055,957	$ 588,088	$ 522,810
At year 20	40,887	12,901,441	3,689,800	3,280,232
Scenario #3 (both areas)				
Same as Scenario #1 at year 10				

Table 6.1.1E: Cumulative value of total acreage in row crops with the mining projects (Run #1)

Crop	Gross Income (Cumulative) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #1, Area 1		
1. Years 1-10		
Corn	$ 3,010,000	$ 545,924
Soybeans	1,190,000	293
Soybeans-	850,000	
Wheat	1,040,000	320,884
Total	6,090,000	867,101
2. Years 1-20		
Corn	8,280,000	1,501,744
Soybeans	3,260,000	802
Soybeans-	2,340,000	
Wheat	2,860,000	882,856
Total	16,740,000	2,385,402
Scenario #1, Area 2		
1. Years 1-10		
Corn	1,540,000	279,310
Soybeans	610,000	150
Soybeans-	430,000	
Wheat	530,000	162,989
Total	3,110,000	442,449
2. Years 1-20		
Corn	5,300,000	961,261
Soybeans	2,080,000	512
Soybeans-	1,500,000	
Wheat	1,840,000	567,065
Total	10,720,000	1,528,838

Table 6.1.1E (Continued)

Crop	Gross Income (Cumulative) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #2, Area 1		
1. Years 1-10		
Corn	3,190,000	578,570
Soybeans	1,260,000	310
Soybeans-	900,000	
Wheat	1,100,000	339,560
Total	6,450,000	918,440
2. Years 1-20		
Corn	16,940,000	3,072,408
Soybeans	6,680,000	1,643
Soybeans-	4,760,000	
Wheat	5,860,000	1,803,064
Total	34,240,000	4,877,115
Scenario #2, Area 2		
1. Years 1-10		
Corn	2,020,000	366,367
Soybeans	800,000	197
Soybeans-	570,000	
Wheat	700,000	215,621
Total	4,090,000	582,185
2. Years 1-20		
Corn	10,740,000	1,947,914
Soybeans	4,240,000	1,043
Soybeans-	3,020,000	
Wheat	3,720,000	1,144,317
Total	21,720,000	3,093,274

Table 6.1.1E (Continued)

Crop	Gross Income (Cum) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #2, Area 3		
1. Years 1-10		
Corn	1,220,000	221,271
Soybeans	480,000	118
Soybeans-	340,000	
Wheat	420,000	129,033
Total	2,460,000	350,422
2. Years 1-20		
Corn	15,060,000	2,731,432
Soybeans	5,920,000	1,456
Soybeans-	4,240,000	
Wheat	5,220,000	1,606,119
Total	30,440,000	4,339,007
Scenario #2, Area 4		
1. Years 1-10		
Corn	270,000	48,970
Soybeans	100,000	25
Soybeans	70,000	
Wheat	90,000	27,165
Total	530,000	76,160
2. Years 1-20		
Corn	480,000	87,058
Soybeans	200,000	49
Soybeans-	140,000	
Wheat	160,000	50,934
Total	980,000	138,041

Scenario #3 (both areas)

Same as Scenario #1, Areas 1 and 2, years 1-10

Table 6.1.1F: Cumulative value of total acreage in row crops without the mining projects (Run #1)

Crop	Gross Income (Cum) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #1, Area 1		
1. Years 1-10		
Corn	3,700,000	671,069
Soybeans	1,460,000	359
Soybeans-	1,040,000	
Wheat	1,280,000	393,890
Total	7,480,000	1,065,318
2. Years 1-20		
Corn	7,400,000	1,342,138
Soybeans	2,920,000	718
Soybeans-	2,080,000	
Wheat	2,560,000	787,779
Total	14,960,000	2,130,636
Scenario #1, Area 2		
1. Years 1-10		
Corn	1,390,000	252,104
Soybeans	550,000	135
Soybeans-	390,000	
Wheat	480,000	147,709
Total	2,810,000	399,948
2. Years 1-20		
Corn	2,780,000	504,209
Soybeans	1,100,000	270
Soybeans-	780,000	
Wheat	960,000	295,417
Total	5,620,000	799,896

Table 6.1.1F (Continued)

Crop	Gross Income (Cum) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #2, Area 1		
1. Years 1-10		
Corn	3,510,000	636,609
Soybeans	1,380,000	340
Soybeans-	990,000	
Wheat	1,220,000	375,214
Total	7,100,000	1,012,163
2. Years 1-20		
Corn	7,020,000	1,273,217
Soybeans	2,760,000	679
Soybeans-	1,980,000	
Wheat	2,440,000	750,428
Total	14,200,000	2,024,324
Scenario #2, Area 2		
1. Years 1-10		
Corn	1,560,000	282,937
Soybeans	610,000	150
Soybeans-	440,000	
Wheat	540,000	166,384
Total	3,150,000	449,471
2. Years 1-20		
Corn	3,120,000	565,874
Soybeans	1,220,000	300
Soybeans-	880,000	
Wheat	1,080,000	332,769
Total	6,300,000	898,943

Table 6.1.1F (Continued)

Crop	Gross Income (Cum) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #2, Area 3		
No land in agricultural production years 1-20		
Scenario #2, Area 4		
1. Years 1-20		
Corn	340,000	61,6661
Soybeans	130,000	32
Soybeans-	100,000	
Wheat	120,000	37,352
Total	690,000	99,050
2. Years 1-20		
Corn	680,000	123,332
Soybeans	260,000	64
Soybeans-	200,000	
Wheat	240,000	74,703
Total	1,380,000	198,099

Scenario #3 (both areas)

Same as Scenario #1, Areas 1 and 2, years 1-10

Table 6.1.1G: Cumulative value of total acreage in row crops with the mining projects (Run #2)

Crops	Gross Income (Cumulative) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #1, Area 1		
1. Years 1-10		
Corn	3,610,000	1,145,489
Soybeans	1,370,000	182,950
Soybeans-	1,170,000	
Wheat	1,160,000	762,050
Total	7,310,000	2,090,489
2. Years 1-20		
Corn	9,920,000	3,147,715
Soybeans	3,760,000	502,110
Soybeans-	3,220,000	
Wheat	3,180,000	2,093,184
Total	20,080,000	5,743,009
Scenario #1, Area 2		
1. Years 1-10		
Corn	1,840,000	583,850
Soybeans	700,000	93,478
Soybeans-	600,000	
Wheat	590,000	389,201
Total	3,730,000	1,066,529
2. Years 1-20		
Corn	6,360,000	2,018,092
Soybeans	2,400,000	320,496
Soybeans-	2,060,000	
Wheat	2,040,000	1,340,946
Total	12,860,000	3,679,534

Table 6.1.1G (Continued)

Crop	Gross Income (Cum) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #2, Area 1		
1. Years 1-10		
Corn	3,820,000	1,212,124
Soybeans	1,450,000	193,633
Soybeans-	1,240,000	
Wheat	1,230,000	807,838
Total	7,740,000	2,213,595
2. Years 1-20		
Corn	20,300,000	6,441,393
Soybeans	7,700,000	1,028,258
Soybeans-	6,600,000	
Wheat	6,520,000	4,291,027
Total	41,120,000	11,760,678
Scenario #2, Area 2		
1. Years 1-10		
Corn	2,420,000	767,890
Soybeans	920,000	122,857
Soybeans-	790,000	
Wheat	780,000	513,484
Total	4,910,000	1,404,231
2. Years 1-20		
Corn	12,880,000	4,086,953
Soybeans	4,880,000	651,675
Soybeans-	4,180,000	
Wheat	4,140,000	2,721,139
Total	26,080,000	7,459,767

Table 6.1.1G (Continued)

Crop	Gross Income (Cum) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #2, Area 3		
1. Years 1-10		
Corn	1,460,000	463,273
Soybeans	550,000	73,447
Soybeans-	470,000	
Wheat	470,000	307,436
Total	2,950,000	844,156
2. Years 1-20		
Corn	18,040,000	5,724,272
Soybeans	6,840,000	913,414
Soybeans-	5,860,000	
Wheat	5,800,000	3,813,520
Total	36,540,000	10,451,206
Scenario #2, Area 4		
1. Years 1-10		
Corn	320,000	101,539
Soybeans	120,000	16,025
Soybeans-	100,000	
Wheat	100,000	65,412
Total	640,000	182,976
2. Years 1-20		
Corn	580,000	184,040
Soybeans	220,000	29,379
Soybeans-	180,000	
Wheat	180,000	117,742
Total	1,160,000	331,161

Scenario #3 (both areas)

Same as Scenario #1, Areas 1 and 2, years 1-10

Table 6.1.1H: Cumulative value of total acreage in row crops without the mining projects (Run #2)

Crop	Gross Income (Cumulative) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #1, Area 1		
1. Years 1-10		
Corn	4,440,000	1,408,856
Soybeans	1,680,000	224,347
Soybeans-	1,440,000	
Wheat	1,420,000	935,392
Total	8,980,000	2,568,595
2. Years 1-20		
Corn	8,880,000	2,817,713
Soybeans	3,360,000	448,694
Soybeans-	2,880,000	
Wheat	2,840,000	1,870,783
Total	17,960,000	5,137,190
Scenario #1, Area 2		
1. Years 1-10		
Corn	1,670,000	529,908
Soybeans	630,000	84,130
Soybeans-	540,000	
Wheat	540,000	353,225
Total	3,380,000	967,263
2. Years 1-20		
Corn	3,340,000	1,059,815
Soybeans	1,260,000	168,260
Soybeans-	1,080,000	
Wheat	1,080,000	706,450
Total	6,760,000	1,934,525

Table 6.1.1H (Continued)

Crop	Gross Income (Cum) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #2, Area 1		
1. Years 1-10		
Corn	4,210,000	1,335,875
Soybeans	1,600,000	213,664
Soybeans-	1,370,000	
Wheat	1,350,000	889,603
Total	8,530,000	2,439,142
2. Years 1-20		
Corn	8,420,000	2,671,750
Soybeans	3,200,000	427,328
Soybeans-	2,740,000	
Wheat	2,700,000	1,779,206
Total	17,060,000	4,878,284
Scenario #2, Area 2		
1. Years 1-10		
Corn	1,870,000	593,370
Soybeans	710,000	94,813
Soybeans-	610,000	
Wheat	600,000	395,743
Total	3,790,000	1,083,926
2. years 1-20		
Corn	3,740,000	1,186,739
Soybeans	1,420,000	189,627
Soybeans-	1,220,000	
Wheat	1,200,000	791,485
Total	7,580,000	2,167,851

Table 6.1.1H (Continued)

Crop	Gross Income (Cum) ($)	Net Return to Land & Mgmt (Cum) ($)
Scenario #2, Area 3		
No land in agricultural production years 1-20		
Scenario #2, Area 4		
1. Years 1-10		
Corn	410,000	130,097
Soybeans	150,000	20,031
Soybeans-	130,000	
Wheat	130,000	85,036
Total	820,000	235,164
2. Years 1-20		
Corn	820,000	260,194
Soybeans	300,000	40,062
Soybeans-	260,000	
Wheat	260,000	170,071
Total	1,640,000	470,327
Scenario #3 (both areas)		
Same as Scenario #1, Areas 1 and 2, years 1-10		

Table 6.1.1I: Summary-- Cumulative value of total acreage in row crops with the mining projects (Run# 1)

	Gross Income (Cumulative) ($)	Net Return to Land & Mgmt (Cum) ($)	Net Income Minus Drainage Cost (Cum) ($)
Scenario #1 (both areas)			
Years 1-10	9,200,000	1,309,550	959,900
Years 1-20	27,460,000	3,914,240	2,869,138
Scenario #2 (all areas)			
Years 1-10	13,530,000	1,927,207	1,412,643
Years 1-20	87,380,000	12,447,437	9,123,971
Scenario #3 (both areas)			
Years 1-10	same as Scenario #1, years 1-10		

Table 6.1.1J: Summary-- Cumulative value of total acreage in row crops without the mining projects (Run #1)

	Gross Income (Cumulative) ($)	Net Return to Land & Mgmt (Cum) ($)	Net Income Minus Drainage Cost (Cum) ($)
Scenario #1 (both areas)			
Years 1-10	10,290,000	1,465,266	1,074,040
Years 1-20	20,580,000	2,930,532	2,148,080
Scenario #2 (all areas)			
Years 1-10	10,940,000	1,560,684	1,143,981
Years 1-20	21,880,000	3,121,366	2,287,961
Scenario #3 (both areas)			
Years 1-10	same as Scenario #1, years 1-10		

Table 6.1.1K: Summary-- Cumulative impacts on row crop agriculture years 1-20 with and without the projects (Run #1) - Net income minus drainage costs ($)

	Years 1-10		Years 1-20	
	With	Without	With	Without
Scenario #1	959,900	1,074,040	2,869,138	2,148,080
Scenario #2	1,412,643	1,143,981	9,123,971	2,287,961
Scenario #3	959,900	1,074,040	-	-

Table 6.1.1L: Summary-- Cumulative value of total acreage in row crops with the mining projects (Run #2)

	Gross Income (Cumulative) ($)	Net Return to Land & Mgmt (Cum) ($)	Net Income Minus Drainage Cost (Cum) ($)
Scenario #1 (both areas)			
Years 1-10	11,040,000	3,157,018	2,314,094
Years 1-20	32,940,000	9,422,543	6,906,724
Scenario #2 (all areas)			
Years 1-10	16,240,000	4,644,958	3,404,754
Years 1-20	104,900,000	30,002,812	21,992,061
Scenario #3 (both areas)			
Years 1-10	same as Scenario #1, years 1-10		

Table 6.1.1M: Summary-- Cumulative value of total acreage in row crops without the mining projects (Run #2)

	Gross Income (Cumulative) ($)	Net Return to Land & Mgmt (Cum) ($)	Net Income Minus Drainage Cost (Cum) ($)
Scenario #1 (both areas)			
Years 1-10	12,360,000	3,535,858	2,591,784
Years 1-20	24,720,000	7,071,715	5,183,567
Scenario #2 (all areas)			
Years 1-10	13,140,000	3,758,232	2,754,784
Years 1-20	26,280,000	7,516,462	5,509,567
Scenario #3 (both areas)			
Years 1-10	same as Scenario #1, years 1-10		

Table 6.1.1N: Summary-- Cumulative impact on row crop agriculture years 1-20 with and without the projects (Run #2) - Net income minus drainage costs ($)

	Years 1-10		Years 1-20	
	With	Without	With	Without
Scenario #1	2,314,094	2,591,784	6,906,724	5,183,567
Scenario #2	3,404,754	2,754,784	21,992,061	5,509,567
Scenario #3	2,314,094	2,591,784	-	-

6.1.1.2.3 Summary and Conclusions

6.1.1.2.3.1 Net Annual Income from Mined Lands Reclaimed to Agriculture

Using the assumptions for Run #1, the annual income at year 20 under Scenario #1 is estimated to be $231,597 on 8,440 acres planted to corn, soybeans and wheat. Annual income under Scenario #2 at year 20 is estimated to be $1,121,789 on 40,887 acres. Under Scenario #3, annual income at year 10 is $36,585 on 1,332 acres.

For Run #2, with the slightly higher prices and a higher yield for soybeans double cropped, the annual income at year 20 under Scenario #1 is estimated to be $677,191 for 8,440 acres planted to corn, soybeans and wheat. Under Scenario #2, with the same crop mix, annual income at year 20 is estimated to be $3,280,232 on 40,887 acres. Annual income under Scenario #3 at year 10 would be $106,948 on 1,332 acres.

6.1.1.2.3.2 Cumulative Value of Agricultural Lands Under the Alternative Scenarios

Based on Run #1 assumptions, cumulative net income minus drainage costs under Scenario #1 for the 20-year study period is approximately $2,869,000 with the projects and $2,148,000 without the projects. Under Scenario #2, cumulative net income for the 20-year period is approximately $9,124,000 with the projects and $2,288,000 without the projects. Estimated cumulative net income under Scenario #3 during the period prior to industry failure and flooding of the permitted areas (years 1-10) is $960,000 with the projects and $1,074,000 without the projects. The with-project loss in agricultural production during years 1-10 under Scenarios #1 and #3 is due to the conversion of agricultural land into mined acreage. Since reclamation in Area 1 (Scenarios #1 and #3) involves the creation of a 1454-acre lake during the first 10 years of mining, more agricultural land is lost to mining than is gained via reclamation during this period. Thus the cumulative value of agricultural production under these two scenarios is lower with the projects than wihout the projects for the first 10 years.

Based on Run #2 assumptions, cumulative net income minus drainage costs for the 20-year period under Scenario #1 is estimated at approximately $6,907,000 with the projects and $5,184,000 without the projects. Under Scenario #2, cumulative net income for the 20 years is about $21,992,000 with the projects and $5,510,000 without the projects. Estimated cumulative net income under Scenario #3 during years 1-10 is approximately $2,314,000 with the projects and $2,592,000 without the project.

The mining projects will thus add between $2.9 and 6.9 million (Scenario #1) or between $9.1 and 22 million (Scenario #2) to the local agricultural economy during the 20-year study period. Under Scenario #3, the local agricultural economy will lose between $114,000 and $278,000 during 10 years of mining.

6.1.2 Forest Products

6.1.2.1 Approach/Assumptions

Data were collected on the present forestry production value of the areas covered by the scenarios prior to peat mining activities. Information on forest products was scarce. No information was obtained for Areas 2 and 4 (Scenario #2). Total acreage of woodland by type was based on habitat type/land use data in Appendix 10.1.

Assumptions made were:

1. The pocosin acreage in Area 1 of Scenario #1 was assumed to have no present timber value (based on discussions with H. Truesdell, First Colony Farms, and Sizemore and Sizemore, a consulting firm that conducted a forest appraisal survey on First Colony Farms in 1978).

2. The current total timber value for Areas 1 and 3 of Scenario #2 was estimated at $1,500,000. Several Atlantic white cedar and swamp hardwood forest stands of high value are located in Area 3, but limited access reduces their value considerably below their potential market value of several million dollars (H. Truesdell, First Colony Farms, personal communication).

3. All timber would be cut once a block was established for peat mining. This would reduce harvest costs and maximize returns.

4. Pine plantation value was based on a per acre value at year 20 (site index 40-60). The value from years 0 to 20 is based roughly on a yield of 35-40 (approximately 2 cords per years) cords per acre for pulpwood at $15-25 per cord value. These values assume a well-managed plantation (fully stocked). The values are prorated and adjusted for future worth at 6% inflation.

5. A large portion of this plantation land will act as a buffer strip and would not be available for harvesting. The amount of this land can not be determined at this time.

6.1.2.2 Data

Table 6.1.2A: Scenario #2 (Areas 1 and 3)-- Value of timber harvested prior to peat mining

Area	Year	Timber Value ($)
1	10	0
1	20	0
3	10	233,000
3	20	1,500,000
Total value		1,500,000

Table 6.1.2B: Scenario #2-- Value of plantation pine if harvested at year 20

Area	Year	Timber Value ($)
1	10	0
1	20	1,291,500 - 2,460,000
2	10	0
2	20	645,750 - 1,230,000
3	10	0
3	20	1,102,500 - 2,100,000
4	10	0
4	20	2,086,875 - 3,975,000
Total value		5,124,000 - 9,765,000

6.1.2.3 Conclusions

The present value of the timber (hardwood, cedar) contained in Areas 1 and 3 of Scenario #2 is approximately $1,500,000. The plantation pine in all four areas will have a $5 - 10 million value at year 20 if 1) it is all harvested and 2) it has been properly managed. The net result will be a gain in timber value due to the activity of peat mining and reclamation in pine plantations. However, Atlantic white cedar habitat will be significantly reduced.

6.1.3 Fish

6.1.3.1 Approach/Assumptions

Major freshwater and estuarine recreational and commercial fisheries occur in and around the Albemarle-Pamlico Peninsula. However, available information is not extensive enough to fully assess the impacts that may occur as a result of the alternative scenarios (see section 7.1).

The literature for North Carolina and other coastal estuarine areas of the United States were examined to determine the results of studies related to the fisheries impacts of altered freshwater flows. (Abstracts of literature reviewed may be found in Appendix 10.3.) Altered salinities and water quality in marine finfish and shellfish nursery grounds are considered negative impacts by many biologists familiar with such areas (Stegman, 1981). The major factors that alter historic freshwater flow patterns and water quality are upstream municipal and industrial development (including dams) and local and upstream agricultural practices. These factors, as well as exploitation, have degraded many fisheries (Rote and Roberts, 1981; Stegman, 1981; Armstrong and Ward, 1981; Spear, 1981). The impacts on estuarine fisheries of large-scale agriculture, forestry and peat mining activities that accelerate drainage and otherwise modify normal movemets, quantities and quality of surface waters are not fully understood and should be investigated further.

6.1.3.2 Conclusions

6.1.3.2.1 Scenario #1

6.1.3.2.1.1 Area 1

The fisheries resources of Area 1 are limited to canals and low order streams. Appreciable sport or commercial fisheries do not exist in the immediate area covered by this scenario, and the species are generally tolerant of low pH-humic waters which may be subject to periodic drying. Drainage and lowered water tables will restrict fish to canal and water storage areas. Reduced flows of streams (all waters are to be stored in temporary ponds) could eliminate fish from small streams during much of the year. Migration and spawning of many species occurs in late winter and spring. Accelerated removal of the waters at this time will limit those activities.

Since lateral seepage is indicated as low in peat soils, water levels of Pungo Lake and Lake Phelps may not be affected by lowering of soil water levels some distance from the lakes. However, alterations of surface drainage patterns to or from the lakes may affect their levels and, consequently, their fisheries.

No other significant effects on the fisheries of Lake Phelps or Pungo Lake are anticipated unless there is increased sedimentation due to wind blown material. An increase in sedimentation could be a significant problem to Lake Phelps, especially since the present levels of suspended residue in this lake are extremely low.

Until water quality and configuration of the storage lakes are more clearly described, predictions of the fish complexes which may develop in the areas are not possible. If the water quality resembles that of Pungo Lake, the fisheries will be less desirable than if the water quality resembles Lake Phelps.

Suspended organic matter (probably of peat origin), low pH, low total hardness and shallow character (less than 3 ft) of Pungo Lake precludes a desirable sport fishery. Species present include yellow bulhead, channel catfish, longnose gar, mosquitofish, and little else. The standing crop is probably less than 40 pounds per acre.

Lake Phelps apparently is not afflicted with as many factors limiting to fish and as a result the fish population is considered more desirable.

No significant effects on anadromous species are expected.

Aquaculture potentials have not been adequately explored and would depend on characteristics of soils, waters and species cultured. Availability of pumping facilities and high quality aquifer water suggest that a potential for this activity exists.

6.1.3.2.1.2 Area 2

Studies of the fish and fisheries of Area 2 have not been conducted, but they are probably similar to those of Area 1.

A difference is that some streams and canals are connected to the Intracoastal Waterway (IWW) and may be periodically invaded by estuarine forms including American eel and herring. Drainage canals opening into the IWW may provide additional spawning sites for herring, but will probably not significantly increase the population of this species. American eel elvers may also use the new environments, but their overall population will probably not be increased.

Drainage of water from Area 2 to the IWW suggests that impacts on Lake Mattamuskeet fisheries will be negligible.

Aquaculture potential is similar to that of Area 1, except that brackish waters may also be available, depending on canal depths in relation to the water level of the IWW.

Waters drained to the IWW would result in increased amplitudes of fresh water during times of high precipitation and reduced fresh water during periods of low rainfall. Thus salinities and flows of the IWW may be affected. Impacts of those changes and the extent to which they may influence the Pungo and Alligator Rivers and their fisheries are not known.

6.1.3.2.2 Scenario #2

6.1.3.2.2.1 Area 1

Impacts on fisheries will be similar to those described in section 6.1.3.2.1.1; however, the volume of drainage water entering the Pungo River via Canal B will be much greater. The effect of this increased runoff on the fisheries in receiving waters is unknown.

6.1.3.2.2.2 Area 2

Impacts on fisheries will be similar to those described in section 6.1.3.2.1.2.

6.1.3.2.2.3 Area 3

Impacts will be similar to Area 2 except that waters would move by sheet flow toward the IWW and the Alligator River. Volumes and periodicities would be determined by velocities of sheet flow, presumably greater than presently occur.

6.1.3.2.2.4 Area 4

The effects of increased amplitudes of fresh water to the Alligator River and its associated fisheries can not be determined until these fisheries are described.

The fisheries that are likely to develop in the lagoons will probably be similar to those described for the water storage areas in section 6.1.3.2.1.1.

6.1.3.2.3 Scenario #3

6.1.3.2.3.1 Area 1

Failure of the industry and flooding of the mined areas will result in fish populations other than those present in streams and canals. Depending on the expanses and depths of the flooded areas, the fish populations will be more or less similar to those currently found in standing waters in the area (see section 6.1.3.2.1.1). If the waters are of appreciable depth and permanent in nature, the freshwater fisheries may be of value as recreational resources and as limited commercial fisheries.

6.1.3.2.3.2 Area 2

Freshwater fisheries impacts will probably be similar to those in Area 1 except that abandoned drainage canals may continue to function and divert surface waters to the IWW. The use of the canals by anadromous and catadromous (American eel) species will depend on flows in the canals and the extent of vegetative re-establishment.

6.1.4 Wildlife

6.1.4.1 Approach/Assumptions

Wildlife habitat impacts were evaluated (Appendix 10.4) through a modified Habitat Evaluation Procedure (HEP) analysis (U.S. Fish and Wildlife Service, 1980) which involved:

1. Inventorying existing habitat-land use types in each project area

2. Selecting an array of "indicator species" representative of various environmental conditions

3. Determining a Habitat Suitability Index (HSI) for each species in each habitat-land use type

4. Selecting a regression that describes the change from one type to another, under each scenario and the no change alternative

5. Computing annualized habitat units (HSI x (type x acres)) for each species for each year during the project period and summing the results as indicators of impacts during the period

6. Computing average HSI's for each species for each area pre- and post-project as static indicators of conditions at those times

Validity of the process depends upon the degree to which the array of species used reflects total "wildlife value" in the area, the validity of the Habitat Suitability Indices (HSIs), and the accuracy with which land use change regressions reflect actual events -- all of which are subject to large error. It does, however, provide a quantitative, reproducible measure of impacts and its assumptions and mathematical functions are declared and can be modified to accommodate differences in opinion and to test sensitivity.

Indicator species and habitat suitability indices were obtained from the North Carolina Wildlife Resources Commission (D. Stewart, North Carolina Wildlife Resources Commission, personal communication). Habitat types and acreages of each habitat type were based on data in Appendix 10.1. Changes in land use over time were based on the scenarios and, for the no change alternative, on reasonable assumptions (e.g., rotation rates on forested lands).

Assumptions made in the simulation were:

Without the project:

1. No timber is harvested from high or low pocosins
2. Agricultural land, residential development, roads and rights-of-way, and other developed area habitat types remain in current acreage
3. Disturbed areas revert to native vegetation in the same proportions as currently exist, as an exponential function over 5 years
4. Forested habitat types are harvested (converted to disturbed land) at exponential rates corresponding to the reciprocal of their rotation period:

Assumed Rotation Ages

Habitat Type	Rotation Period (years)
Evergreen forest	30
Mixed forest	60
Deciduous forest	60
White cedar swamp	80
Mixed swamp	80
Bay forest	100

5. All inactive unreclaimed mine reverts to water and marsh habitat as a linear function over 5 years

With the project - all scenarios:

1. Habitat types are converted to peat mine in the same proportions as they currently exist
2. Inactive mine that is reclaimed as native vegetation reverts to each native vegetation habitat type in the same proportion as it currently exists

6.1.4.2 Data

Table 6.1.4A: Scenario #1-- Total accrued annualized habitat units at the end of the project period, with and without the project

	With	Without	Difference	% Change
Area 1	56,594	64,828	-8,234	-12.7
Area 2	26,604	31,259	-4,655	-14.9
Total	83,198	96,087	-12,889	-13.4

Table 6.1.4B: Scenario #1, Area 1-- Accrued annualized habitat units at end of project period, with and without the project, by species

Species	With	Without	Difference	% Change
Black bear	5,975	9,470	-3,485	-36.8
Whitetail deer	8,201	8,586	- 385	- 4.5
Marsh rabbit	5,916	8,375	-2,459	-29.4
Muskrat	3,804	3,110	+ 694	+22.3
Bobwhite	8,043	6,905	+1,138	+16.5
Mourning dove	6,776	4,707	+2,069	+44.0
Great horned owl	6,244	5,837	+ 407	+ 7.0
Pine warbler	2,173	4,313	-2,140	-49.6
Hairy woodpecker	2,333	4,515	-2,182	-48.3
Bobcat	7,129	9,009	-1,880	-20.9

Table 6.1.4C: Scenario #1, Area 2-- Accrued annualized habitat units at end of project period, with and without the project, by species

Species	With	Without	Difference	% Change
Black bear	2,771	4,188	-1,417	-33.8
Whitetail deer	3,730	4,004	- 274	- 6.8
Marsh rabbit	2,283	3,206	- 923	-28.8
Muskrat	1,334	988	+ 346	+35.0
Bobwhite	3,767	3,244	+ 543	+16.7
Mourning dove	3,423	2,474	+ 949	+38.4
Great horned owl	2,932	3,061	- 129	- 4.2
Pine warbler	1,668	3,114	-1,446	-46.4
Hairy woodpecker	1,512	2,837	-1,325	-46.7
Bobcat	3,184	4,143	- 959	-23.1

Table 6.1.4D: Scenario #1-- Average Habitat Suitability Index, by species, for the beginning and end of the project period, with and without the project

Species	Beginning of Period	End of Period	
		Without Project	With Project
Area 1			
Black bear	0.48	0.63	0.31
Whitetail deer	0.63	0.52	0.47
Marsh rabbit	0.42	0.56	0.32
Muskrat	0.20	0.20	0.29
Bobwhite	0.60	0.40	0.51
Mourning dove	0.48	0.25	0.48
Great horned owl	0.48	0.34	0.36
Pine warbler	0.16	0.30	0.15
Hairy woodpecker	0.19	0.31	0.13
Bobcat	0.57	0.57	0.37
Area 2			
Black bear	0.52	0.61	0.30
Whitetail deer	0.62	0.55	0.48
Marsh rabbit	0.41	0.47	0.25
Muskrat	0.16	0.14	0.25
Bobwhite	0.56	0.43	0.57
Mourning dove	0.45	0.31	0.59
Great horned owl	0.48	0.41	0.38
Pine warbler	0.31	0.45	0.19
Hairy woodpecker	0.30	0.41	0.15
Bobcat	0.58	0.58	0.35

Table 6.1.4E: Scenario #2-- Total accrued annualized habitat units at the end of the project period, with and without the project

	With	Without	Difference	% Change
Area 1	103,534	125,601	-22,067	-17.6
Area 2	53,301	64,100	-10,799	-16.8
Area 3	95,196	117,228	-22,032	-18.8
Area 4	42,761	56,302	-13,541	-24.1
Total	294,791	363,230	-68,439	-18.8

Table 6.1.4F: Scenario #2, Area 1-- Accrued annualized habitat units at the end of the project period, with and without the project, by species

Species	With	Without	Difference	% Change
Black bear	12,031	20,057	-8,026	-40.0
Whitetail deer	14,206	16,311	-2,105	-12.9
Marsh rabbit	11,632	17,304	-5,672	-32.8
Muskrat	6,818	4,709	+2,109	+44.8
Bobwhite	13,313	11,606	+1,707	+14.7
Mourning dove	11,118	6,489	+4,629	+71.3
Great horned owl	10,460	10,747	- 287	- 2.7
Pine warbler	5,554	9,752	-4,198	-43.0
Hairy woodpecker	5,481	10,254	-4,773	-46.5
Bobcat	12,920	18,371	-5,451	-29.7

Table 6.1.4G: Scenario #2, Area 2-- Accrued annualized habitat units at end of project period, with and without the project, by species

Species	With	Without	Difference	% Change
Black bear	6,276	9,948	- 3,672	-36.9
Whitetail deer	7,149	8,114	- 965	-11.9
Marsh rabbit	5,449	8,355	- 2,906	-34.8
Muskrat	2,832	2,162	+ 670	+31.0
Bobwhite	6,775	5,694	+ 1,081	+19.0
Mourning dove	5,962	3,391	+ 2,571	+75.8
Great horned owl	5,394	5,714	- 320	- 5.6
Pine warbler	3,612	5,774	- 2,162	-37.4
Hairy woodpecker	3,356	5,750	- 2,394	-41.6
Bobcat	6,496	9,198	- 2,702	-29.4

Table 6.1.4H: Scenario #2, Area 3-- Accrued annualized habitat units at end of project period, with and without the project, by species

Species	With	Without	Difference	% Change
Black bear	12,385	19,482	- 7,097	- 36.4
Whitetail deer	12,640	15,416	- 2,776	- 18.0
Marsh rabbit	10,118	14,546	- 4,428	- 30.4
Muskrat	4,600	2,643	+ 1,957	+ 74.0
Bobwhite	10,347	9,544	+ 803	+ 8.4
Mourning dove	8,646	4,389	+ 4,257	+ 97.0
Great horned owl	9,965	10,389	- 424	- 4.1
Pine warbler	7,078	11,352	- 4,274	- 37.6
Hairy woodpecker	7,456	12,148	- 4,692	- 38.6
Bobcat	11,961	17,318	- 5,357	- 30.9

Table 6.1.4I: Scenario #2, Area 4-- Accrued annualized habitat units at the end of the project period, with and without the project, by species

Species	With	Without	Difference	% Change
Black bear	5,750	9,018	- 3,268	- 36.2
Whitetail deer	5,379	7,495	- 2,116	- 28.2
Marsh rabbit	5,977	7,361	- 1,384	- 18.8
Muskrat	3,067	1,711	+ 1,356	+ 79.3
Bobwhite	3,472	4,883	- 1,411	- 28.9
Mourning dove	2,473	2,597	- 124	- 4.8
Great horned owl	4,580	5,323	- 743	- 14.0
Pine warbler	2,919	4,483	- 1,564	- 34.9
Hairy woodpecker	3,415	5,051	- 1,636	- 32.4
Bobcat	5,728	8,379	- 2,651	- 31.6

Table 6.1.4J: Scenario #2-- Average Habitat Suitability Index, by species, for the beginning and end of the project period, with and without the project

Species	Beginning of Period	End of Period	
		Without Project	With Project
Area 1			
Black bear	0.60	0.69	0.27
Whitetail deer	0.59	0.53	0.44
Marsh rabbit	0.51	0.59	0.27
Muskrat	0.16	0.16	0.33
Bobwhite	0.48	0.36	0.53
Mourning dove	0.32	0.19	0.57
Great horned owl	0.42	0.34	0.34
Pine warbler	0.25	0.34	0.16
Hairy woodpecker	0.28	0.36	0.12
Bobcat	0.61	0.61	0.31
Area 2			
Black bear	0.63	0.67	0.27
Whitetail deer	0.56	0.54	0.47
Marsh rabbit	0.53	0.57	0.22
Muskrat	0.15	0.14	0.28
Bobwhite	0.42	0.37	0.59
Mourning dove	0.27	0.21	0.64
Great horned owl	0.41	0.37	0.37
Pine warbler	0.36	0.39	0.17
Hairy woodpecker	0.36	0.39	0.12
Bobcat	0.61	0.61	0.31

Table 6.1.4J (continued)

Species	Beginning of Period	End of Period Without Project	End of Period With Project
Area 3			
Black bear	0.76	0.76	0.27
Whitetail deer	0.59	0.59	0.47
Marsh rabbit	0.59	0.56	0.22
Muskrat	0.13	0.09	0.28
Bobwhite	0.32	0.36	0.59
Mourning dove	0.15	0.15	0.64
Great horned owl	0.46	0.38	0.37
Pine warbler	0.43	0.46	0.17
Hairy woodpecker	0.49	0.48	0.13
Bobcat	0.67	0.67	0.31
Area 4			
Black bear	0.71	0.72	0.31
Whitetail deer	0.58	0.56	0.35
Marsh rabbit	0.59	0.58	0.53
Muskrat	0.17	0.12	0.36
Bobwhite	0.32	0.36	0.21
Mourning dove	0.18	0.17	0.20
Great horned owl	0.49	0.37	0.25
Pine warbler	0.34	0.37	0.22
Hairy woodpecker	0.43	0.41	0.20
Bobcat	0.65	0.64	0.30

Table 6.1.4K: Scenario #3-- Total accrued annualized habitat units at the end of the project period, with and without the project

	With	Without	Difference	% Change
Area 1	58,035	64,828	-6,793	-10.5
Area 2	26,878	31,259	-4,381	-14.0
Total	84,913	96,987	-11,174	-11.6

Table 6.1.4L: Scenario #3, Area 1-- Accrued annualized habitat units at the end of the project period, with and without the project, by species

Species	With	Without	Difference	% Change
Black bear	6,339	9,470	-3,131	-33.1
Whitetail deer	8,267	8,586	- 319	- 3.7
Marsh rabbit	7,017	8,375	-1,358	-16.2
Muskrat	4,911	3,110	+1,801	+57.9
Bobwhite	7,652	6,905	+ 747	+10.8
Mourning dove	5,963	4,707	+1,256	+26.7
Great horned owl	6,210	5,837	+ 373	+ 6.4
Pine warbler	1,916	4,313	-2,397	-55.6
Hairy woodpecker	2,247	4,515	-2,268	-50.2
Bobcat	7,513	9,009	-1,496	-16.6

Table 6.1.4M: Scenario #3, Area 2-- Accrued annualized habitat units at the end of the project period, with and without the project, by species

Species	With	Without	Difference	% Change
Black bear	2,965	4,188	-1,153	-27.6
Whitetail deer	3,621	4,004	- 383	- 9.6
Marsh rabbit	3,026	3,206	- 180	- 5.6
Muskrat	2,028	988	+1,040	+105.3
Bobwhite	3,272	3,244	+ 28	+ 0.9
Mourning dove	2,646	2,474	+ 172	+ 7.0
Great horned owl	2,814	3,061	- 247	- 8.1
Pine warbler	1,608	3,114	-1,506	-48.4
Hairy woodpecker	1,526	2,837	-1,311	-46.2
Bobcat	3,373	4,143	- 770	-18.6

Table 6.1.4N: Scenario #3-- Average Habitat Suitability Index, by species, for the beginning and end of the project period, with and without the project

Species	Beginning of Period	End of Period Without Project	End of Period With Project
Area 1			
Black bear	0.48	0.63	0.39
Whitetail deer	0.63	0.52	0.49
Marsh rabbit	0.42	0.56	0.53
Muskrat	0.20	0.20	0.46
Bobwhite	0.60	0.40	0.43
Mourning dove	0.48	0.25	0.31
Great horned owl	0.48	0.34	0.36
Pine warbler	0.16	0.30	0.10
Hairy woodpecker	0.19	0.31	0.12
Bobcat	0.57	0.57	0.45
Area 2			
Black bear	0.52	0.61	0.40
Whitetail deer	0.62	0.55	0.45
Marsh rabbit	0.41	0.47	0.53
Muskrat	0.16	0.14	0.47
Bobwhite	0.56	0.43	0.37
Mourning dove	0.45	0.31	0.27
Great horned owl	0.48	0.41	0.34
Pine warbler	0.31	0.45	0.18
Hairy woodpecker	0.30	0.41	0.17
Bobcat	0.58	0.58	0.44

6.1.4.3 Conclusions

6.1.4.3.1 Scenario #1

With the mining projects, total accrued annualized habitat units, summed over all species, will be 13% less in Area 1, 15% less in Area 2, and 13% less in the entire project area than without the projects (Table 6.1.4A). This summation confounds gains and losses among the indicator species, equates all species, and assumes comparability and linearity among all components of the model. A more valuable interpretation may be gained by examining impacts upon individual species.

Black bear, pine warbler and hairy woodpecker will be most severely (adversely) affected by the mining projects. Overall habitat suitability (Table 6.1.4D) will be reduced about 50%. During the 20-year project period, habitat suitability with the projects will be 50-60% of no-project conditions (accrued annualized habitat units, Tables 6.1.4B and C). These species are associated more with native vegetation (pocosin, swamp and evergreen forest) than with the water and marsh, agriculture and mined areas characteristic of during-project and post-project conditions. The bear, a wilderness animal which cannot survive in areas intensively modified by man, will have an overall Habitat Suitability Index (HSI) of 0.2 following the 20-year project period (Table 6.1.4D) and a habitat quality reduction of 63% (Area 1) and 51% (Area 2) during-project operation (Tables 6.1.4B and C).

With mining, marsh rabbit and bobcat will sustain moderately negative impacts. Habitat suitability for both will decrease about 35% in Area 1 and over 40% in Area 2 (Table 6.1.4D). The increase in water and marsh (HSI=0.7), suitable habitat for marsh rabbits, will not offset the increase in unsuitable agriculture and mining (HSI=<0.2). The bobcat is associated with native vegetation (HSI=>0.5); habitat quality will be reduced 21% (Area 1) and 23% (Area 2) (Tables 6.1.4B and C) during the project period, and post-project habitat quality will be reduced 35% (Area 1) and 40% (Area 2) from without-project conditions.

With the projects, whitetail deer will experience a 10% decrease in HSI in Area 1 and a 13% decrease in Area 2, compared to no-project conditions (Table 6.1.4D), and a 4-7% decrease during the projects (Tables 6.1.4B and C).

Muskrat, bobwhite, mourning dove and great horned owl will all benefit from the projects. The muskrat will gain about 22% (Area 1) and 35% (Area 2) during-project operation (Table 6.1.4B and C), but will have an overall suitability of 0.25-0.29 at project conclusion. The mourning dove will gain 44% (Area 1) and 38% (Area 2) during the projects (Tables 6.1.4B and C), and post-project conditions will be 92% (Area 1) to almost 200% (Area 2) better than no-project conditions (Table 6.1.4D). Conditions for great horned owls will improve about 7% in Area 1 and decline 4% in Area 2 during-project operation (Table 6.1.4B and C), and will be about the same, with or without the projects, after the 20-year period (Table 6.1.4D).

6.1.4.3.2 Scenario #2

Total accrued annualized habitat units, with the mining projects will be less than without the projects in each area, summing over all species (Table 6.1.4E). The decline in total habitat units will be 18% in Area 1, 17% in Area 2, 19% in Area 3 and 24% in Area 4. Overall, habitat quality (as measured by the evaluation species cited) will decrease 19% from without-project conditions.

Black bears will lose 60% or more in habitat suitability in three of the four areas with the projects compared to no-project conditions at the end of the period (Table 6.1.4J). Loss of accrued annualized habitat units will range from 36% (Areas 3 and 4) to 40% (Area 1) during the projects (Tables 6.1.4F-I) due to conversion of land from native vegetation to agricultural land in Areas 1, 2 and 3 and conversion to residential property and water in Area 4. Whitetail deer will lose 38% in habitat suitability in Area 4 with the project compared to no-project conditions because of the residential land (HSI= 0.02) and 4280-acre water body (HSI=0.23) planned for reclamation. The conversion to residential property and lake areas in Area 4 will be accompanied by a substantial loss of habitat units (28%) during-project operation (Table 6.1.4F). The habitat suitability for deer in Areas 1, 2 and 3 will decline 20% or less (Table 6.1.4J). Habitat unit losses in Areas 1, 2 and 3 during-project operation will be less than 20% (Tables 6.1.4G-I).

Land conversion with the projects will severely reduce the habitat suitability for marsh rabbit, pine warbler, hairy woodpecker and bobcat in Areas 1, 2 and 3 over the no-project alternative (Table 6.1.4J). Habitat quality for marsh rabbit will be reduced because of the loss of low pocosin vegetation (HSI=0.54-0.66) and conversion to mined land (HSI=0.06) and agriculture (HSI=0.18)--partially off-set by the increase in water (HSI=0.7) in Area 4. The rabbit HSI for water was originally intended for small-area water bodies such as canals, and for marshy areas. The 4280-acre water body in Area 4 will not be suitable habitat for marsh rabbits, but was assigned a HSI of 0.7 in this analysis. Thus the impacts of the mining project upon this species in Area 4 have been underestimated. Habitat unit loss during-project operation will be about 30% in Areas 1, 2, and 3, and 19% in Area 4 (Tables 6.1.4F-I).

Original habitat conditions are only fair in all areas for pine warbler and hairy woodpecker (HSI=0.25-0.43 for warbler and HSI=0.28-0.49 for woodpecker) (Table 6.1.4J). For both species, habitat will become marginal under project conditions (HSI generally less than 0.2) (Table 6.1.4J).

Bobcat habitat suitability will decrease about 30% during the projects (Tables 6.1.4F-I), and resultant HSIs will be about 50% less than under no-project conditions (Table 6.1.4J).

Muskrat, bobwhite and mourning dove will experience substantial increases in habitat suitability under project conditions, with muskrat and mourning dove habitat more than doubling in quality (Table 6.1.4J). These species are associated with agriculture and/or water, both of which increase in all areas. Initial habitat suitability for muskrat is poor in all areas (HSI=<0.2). Although habitat quality will be greatly improved with the projects (HSI=about 0.3), it will still not be high enough to consider any of the areas (in total) really suitable for muskrat (Table 6.1.4J). Canals and water bodies created by the projects will, however, provide excellent, localized muskrat habitat.

Habitat quality for great horned owl will be relatively unaffected by the projects (Tables 6.1.4F-I), except in Area 4 where conversion to residential property (HSI=0.3) and water (HSI=0.15) will reduce overall quality by about 30% (Table 6.1.4J).

6.1.4.3.3 Scenario #3

With the mining projects, total accrued annualized habitat units, summed over all species, will be 11% less in Area 1 and 14% less in Area 2 than without the projects (Table 6.1.4K). Overall, habitat quality will decrease about 12% (as measured by the evaluation species used).

Pine warbler and hairy woodpecker will experience the greatest loss in habitat suitability with the mining projects compared to no-project conditions at the end of the period (Table 6.1.4N). Loss of accrued annualized habitat units will range from 46% to 56% during the projects (Tables 6.1.4L and M). Currently, the area is not well suited for either species (pine warbler HSI=0.16-0.31; hairy woodpecker HSI=0.19-0.30).

Black bear will lose 34-38% in habitat quality, compared to without-project conditions (Table 6.1.4N), and accrued habitat units will be 28-33% less than under without-project conditions (Tables 6.1.4L and M). Bobcats will sustain less, but still substantial, reduction in habitat quality under project conditions--about 18% in accrued habitat units (Tables 6.1.4L and M) and 20-30% in post-project conditions (Table 6.1.4N).

Whitetail deer, marsh rabbit and great horned owl will be only slightly affected by project conditions; with-project HSIs and accrued habitat units will be within +20% (and usually within +10%) of without-project values (Table 6.1.4N).

Muskrat, bobwhite and mourning dove will all benefit from the projects, with gains of more than 200% in the case of mourning dove (Table 6.1.4N). These species are characteristic of agricultural and aquatic environments, which expand as a result of the mining projects.

6.1.4.3.4 Summary

Project impacts can be evaluated in terms of magnitude, significance, and possible mitigation.

Pine warblers and hairy woodpeckers will sustain the greatest overall habitat degradation under project conditions (generally 50-60%). Both species are relatively common, widely distributed and tolerant of human activity. No population of either species will be jeopardized and mitigation is probably unnecessary.

Black bears and bobcats will sustain proportionately less loss (generally 20-40%). These species are much more narrowly distributed, and the bear is particularly intolerant of disturbance and human activity. HSIs used in this analysis were based upon professional opinion; during- and post-project values were dependent upon estimates of the effects of mitigation measures (buffer strips, corridors, habitat type interspersion) which have not yet been tested. The implications of potential habitat loss and of errors in the HSIs used are therefore substantial. If necessary, additional mitigation measures could be required by modifying existing permits to reduce the acreage disturbed or to require greater reforestation in the reclamation plans. Legal authority for permit and reclamation plan modification is granted by G. S. 74-51 (6th paragraph) and G. S. 74-57. Additional strength is given to permit and plan modifications to mitigate loss of wildlife resources by G. S. 74-51, which makes "unduly adverse effects on wildlife" a ground for denying a permit for any mining operation.

Whitetail deer and the great horned owl will be only slightly affected by the projects, except in Area 4 of Scenario #2, where residential development and open water reclamation will decrease available habitat.

The marsh rabbit is widely distributed through the lower Coastal Plain and will be moderately, though variably, impacted by the projects. This species has not been intensively studied in North Carolina, however, and results reported here may be subject to considerable error.

Species benefitting from the projects -- muskrat, bobwhite, and mourning dove -- are all common and widely distributed.

6.1.5 Recreation

6.1.5.1 Approach/Assumptions

1. The literature was analyzed for data on the present recreational value of the areas included in the scenarios prior to peat mining activities.

2. The acreage figures of peatland by land use category at year zero (T=0) for Scenarios #1 and #2 are based on habitat type/land use data in Appendix 10.1. These data were used to calculate the actual recreation value at T=0. Cropland was not given a hunting value since access to the land was assumed to be restricted. (If this assumption is not met, then recreational hunting values would not change; however, game species would change significantly.)

3. The recreational value of pocosins prior to development was based on Postel (1981).

4. The primary use of pocosin lands for recreation is for hunting and fishing (Richardson, 1981). Under the moderate assumptions of a $5.00 per trip hunting value, a 9% benefit appreciation rate and a 7% interest rate, hunting benefits yield a present worth of $36 per acre over a twenty-year period (Postel, 1981). This does not take into account the downstream benefits related to the role of pocosins in estuarine water quality maintenance, which may control an annual $500 million fishing industry. Other nonquantifiable benefits include critical habitat maintenance, ecosystem preservation and option value to future generations.

5. The loss in recreational value due to the conversion of pocosin ecosystems as well as surrounding swamp forest, cropland and marsh habitat was based on the acreage in a somewhat natural state at T=0 multiplied by $36 per acre, minus the acreage of landscape converted to peat mining at time T+1 times $36 per acre. This simplistic approach does not take into account the opportunity costs of development and was chosen since a marginal analysis of these opportunity costs was not possible. The acres that are calculated to be reclaimed at each calculation period are added back into the value at $36 per acre. The data representing an estimate of changes in recreational value due to peat mining are shown in Table 6.1.6A.

6.1.5.2 Data

Table 6.1.5A-- Estimated changes in recreational value (primarily hunting) based on a value of $36/acre over 20 yrs

Scenario	Area	Year	Total Value	Value Lost
1	1	0	$ 452,156	$ -
1	1	10	177,994	274,162
1	1	20	121,174	330,982
1	2	0	222,486	-
1	2	10	73,513	148,973
1	2	20	40,872	181,614
Total loss for Scenario #1 (all areas) at year 20				$ 512,596
2	1	0	$ 978,486	$ -
2	1	10	393,177	585,309
2	1	20	98,477	880,009
2	2	0	500,237	-
2	2	10	196,588	303,649
2	2	20	49,238	450,999
2	3	0	952,832	-
2	3	10	353,926	598,906
2	3	20	84,065	868,767
2	4	0	462,124	-
2	4	10	168,431	293,693
2	4	20	77,100	385,024
Total loss for Scenario #2 (all areas) at year 20				$2,584,799

Notes:
$ value of forest and native land assumed to be $36/acre
$ value/acre of pasture, cropland, mining area and open water all assumed to be 0; thus, value of forest and native land assumed to equal total value of all acreage in permitted area

6.1.5.3 Conclusions

An estimate of the loss in value over 20 years in terms of hunting recreational value in Scenario #1 is roughly $512,600 (Table 6.1.5A). This assumes that cropland is not available to hunters in the future and that a portion of the peat mine is not yet reclaimed. In Scenario #2 the total loss of recreational value in Areas 1, 2, 3 and 4 of Scenario #2 due to peat mining is approximately $2.6 million when projected over the next 20 years (Table 6.1.5A). In both cases, the estimated losses in recreational value are based on an assumed value of $5.00 per hunting trip.

6.2 Water

6.2.1 Surface Water

6.2.1.1 Amount of Surface Water Runoff

6.2.1.1.1 Approach/Assumptions

6.2.1.1.1.1 Scenario #1

For the analysis of Scenario #1, Area 1 was considered to consist of 45 333-acre blocks permitted for methanol production and 800 acres permitted for horticultural peat production. The pre-mining conditions were based on habitat type/land use data in Appendix 10.1. The habitat type data and PMA's 'Peat Harvesting Sequence' (PMA, 1983d, Fig. 2-10) were used to determine the number of acres existing in each land use condition in Table 6.2.1.1A at any one time. Pre-mining disturbed land was equivalent to habitat type categories (Appendix 10.1) 'agricultural land' and 'disturbed land - transitional/field ditched'. This category thus includes all land ditched and recently cleared for agriculture including burned and rejuvenated areas and pasture land. These areas were all modeled as pasture sites with field ditches spaced 330 feet apart. Pre-mining shrub encompassed high and low pocosin areas. These areas were modeled assuming a standard ditched area as for pasture with increased rooting depths and surface storage. For the first ten years an extra 80 acres per year (1/4 block) were considered cleared for mining in areas producing horticultural peat (Area 1).

A block was considered to be in pre-mined condition until the second year of bog preparation. (Bog preparation involves digging an extra drainage ditch between the existing ditches, breaking down and grinding up the vegetation and land forming the block to encourage rapid surface drainage.) From the beginning of the second year of bog preparation the block was considered to be in the mined condition. Increased runoff may be expected with the removal of vegetation but not to the extent modeled for the actively mined phase. The one year delay in considering a block in the mined condition was an attempt to account for this progressive change in expected runoff.

Reclaimed land not used for the lake in Area 1 was assumed to be in 80% agriculture (row crop rotation with poor subsurface drainage), 10% forestry and 10% native vegetation (see section 5.2.2.10). Reclaimed native vegetation was considered the same as forestry in the analysis. If reclamation was scheduled to begin before the end of the first quarter of a particular year, a block was considered reclaimed for that entire year. If reclamation was not scheduled to begin until after the first quarter, the block was considered in the mined condition until the following year. All land being mined for horticultural peat was assumed reclaimed to agriculture and forestry in year 11.

At the completion of mining, the soil surface will be fairly well compacted from the continuous passage of heavy harvesting equipment. High surface runoff may be expected prior to plowing and planting. Although it will take several seasons of plant residue incorporation and fertilization to produce the soil type assumed for after mining agriculture and forestry, the most significant effect of reclamation will be the alteration of evapotranspiration. These effects will begin immediately after planting of the first crop. Once a crop is planted, transpiration will increase significantly over the during mining condition, lowering the water table and reducing runoff. Assuming quick reclamation is thus considered reasonable.

Average total annual flows from 20 years of simulation were generated for each of the land surface conditions (Table 6.2.1.1A) using the models described in Gregory et al. (1984). The slight differences from values reported in section 5.2.2.4 are due to improved records of rainfall data for the simulations. Flows from pre-mining shrub areas are higher than flows from post-mining agriculture because of the difference in soil type. Although the shrub has a deeper root depth than the row crops, in the post-mining mineral soil more water is available to the plant for evapotranspiration, resulting in deeper water tables and, therefore, less runoff. Flows were weighted by their various areas throughout the study period to determine an expected average annual flow per unit area for all 20 years (Table 6.2.1.1A). The assumed acreage by land use category for each scenario and area for the 20 year study period may be found in Appendix 10.5. In year 10 the land used for the large temporary lake was assumed to revert back to pasture before being mined at a later date. The 20 year maximum and minimum flows were also considered throughout the study period. The resulting expected average, maximum and minimum annual flows per unit area for Scenario #1, Area 1, for the 20 year study period are plotted in Figure 6.2.1.1A. The plant discharge of 870,000 gallons per day (0.7 inches per year over the entire Area 1) was added to the flow for all years after year 0. (The horizontal lines in Figures 6.2.1.1A-F represent the no project condition (i.e., the average annual flow at year 0).)

For Area 2 of Scenario #1, precise mining strategy was not available. It was assumed for this analysis that 300 acres were prepared for mining each year up to a maximum of 1,500 acres. An extra 300 acres were included in the active mining condition for each year to simulate areas in bog preparation and areas mined but not yet reclaimed. The land use areas were taken from data on acreage by habitat type in Appendix 10.1 and each of the non-forested areas was assumed to be depleted at a rate proportional to the original habitat type acreage. The assumed acreages of each land use thoughout the 20 year study period are given in Appendix 10.5. As with Area 1, forested areas were assumed to be replenished at a rate equal to 20 percent of the reclaimed area. Differences in hydrology between forestry on the reclaimed areas and on the original peat soil were found to be small (less than 2%) and consequently the same annual flow totals were used for both. The predicted average, maximum and minimum total flows for Scenario #1, Area 2, for the 20 year study period are shown in Figure 6.2.1.1B.

6.2.1.1.1.2 Scenario #2

For Scenario #2, all areas, the initial land use types were taken from the habitat type data in Appendix 10.1. Each was depleted at a rate proportional to the initial habitat type acreage. Different mining rates were used from those reported in section 5.2.3.2.4. In order for the required acreage to be mined by year 10 and 20 as given in section 5.2.3.2.1 and assuming that it takes 5 years to mine out a block, the acreage mined at year ten must be in the active mining state by year 5. Similarly, in order to finish mining an area by year 20, all acreage must be reclaimed or in active mining state by year 15. Thus the following average annual rates of land disturbance were used in this analysis:

	1 - 5	6 - 10	11 - 15	16 - 20
Area 1	1500	1800	2700	0
Area 2	750	900	1350	0
Area 3	1100	1600	2500	0
Area 4	680	770	1150	0

Using the above rates and the given existing land use types, the acreages for each year of operation were calculated and are given in Appendix 10.5. Residential areas in Area 4 were modeled as an active peat mine to simulate the high surface runoff expected for a residential area. Accurate urban modeling is not possible at this stage because of lack of information about the nature of the residential areas and because the model used in this analysis is not designed to handle urban areas. The resulting predicted average, maximum and minimum annual flows per unit area for Scenario #2, Areas 1, 2, 3 and 4, for the 20 year study period are shown in Figures 6.2.1.1C-F, respectively.

6.2.1.1.2 Data

Table 6.2.1.1A: Annual flow totals per unit area generated from 20 years of simulation. (Average annual rainfall for the 20 years is 48.4 inches.)

Land Use	Average Annual Flow in/year	20 Year Maximum in/year	20 Year Minimum in/year
Lake	9.8	17.6	-4.6
Pre-mining Disturbed	18.7	29.5	9.1
Pre-mining Shrub	14.5	27.4	4.3
Active Mine	24.1	32.2	12.8
Agriculture	14.3	25.8	3.4
Forestry	12.6	24.3	1.5

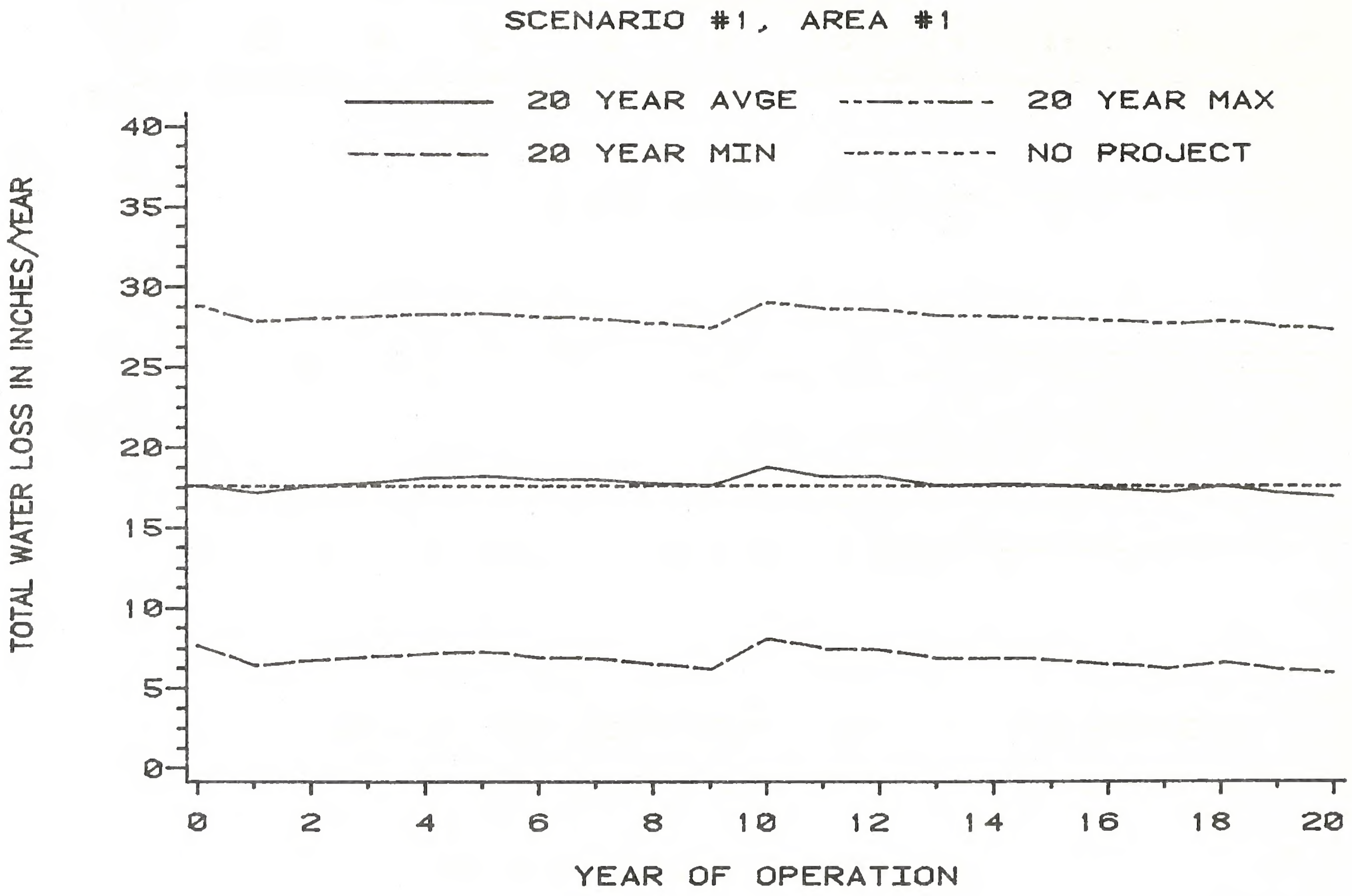


Figure 6.2.1.1A: Scenario #1, Area 1-- Total annual flow (inches per year)

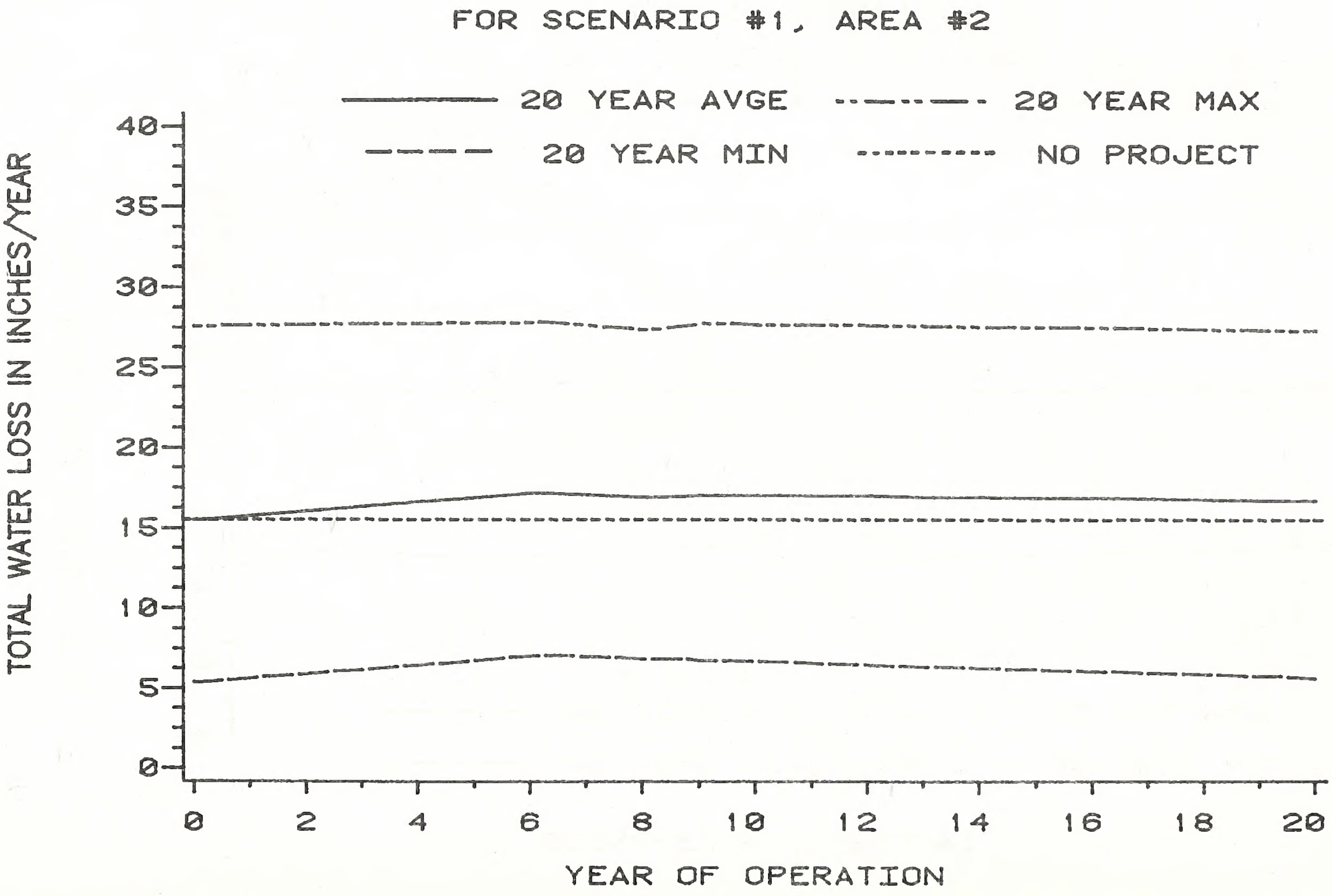


Figure 6.2.1.1B: Scenario #1, Area 2-- Total annual flow (inches per year)

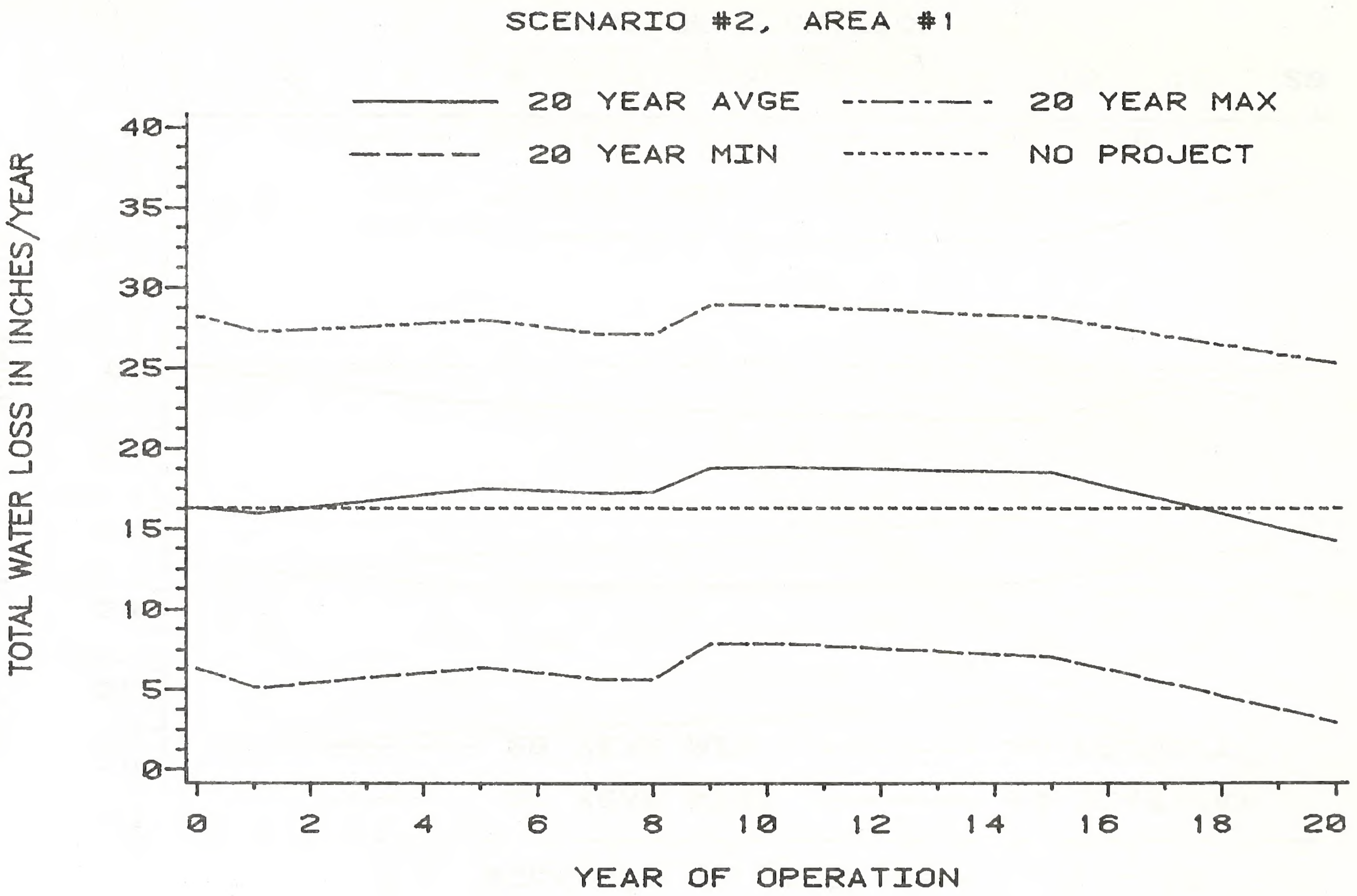


Figure 6.2.1.1C: Scenario #2, Area 1-- Total annual flow (inches per year)

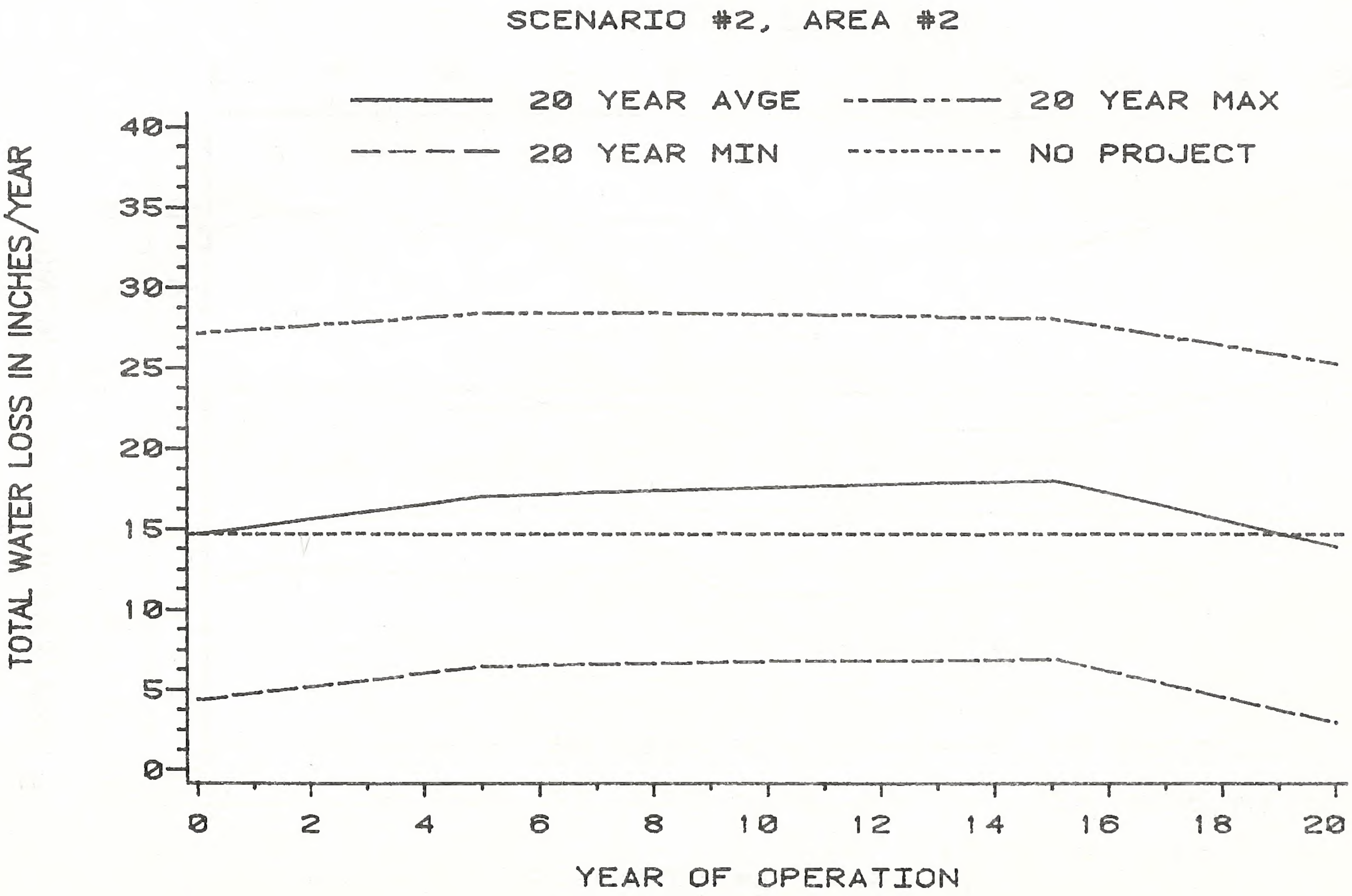


Figure 6.2.1.1D: Scenario #2, Area 2-- Total annual flow (inches per year)

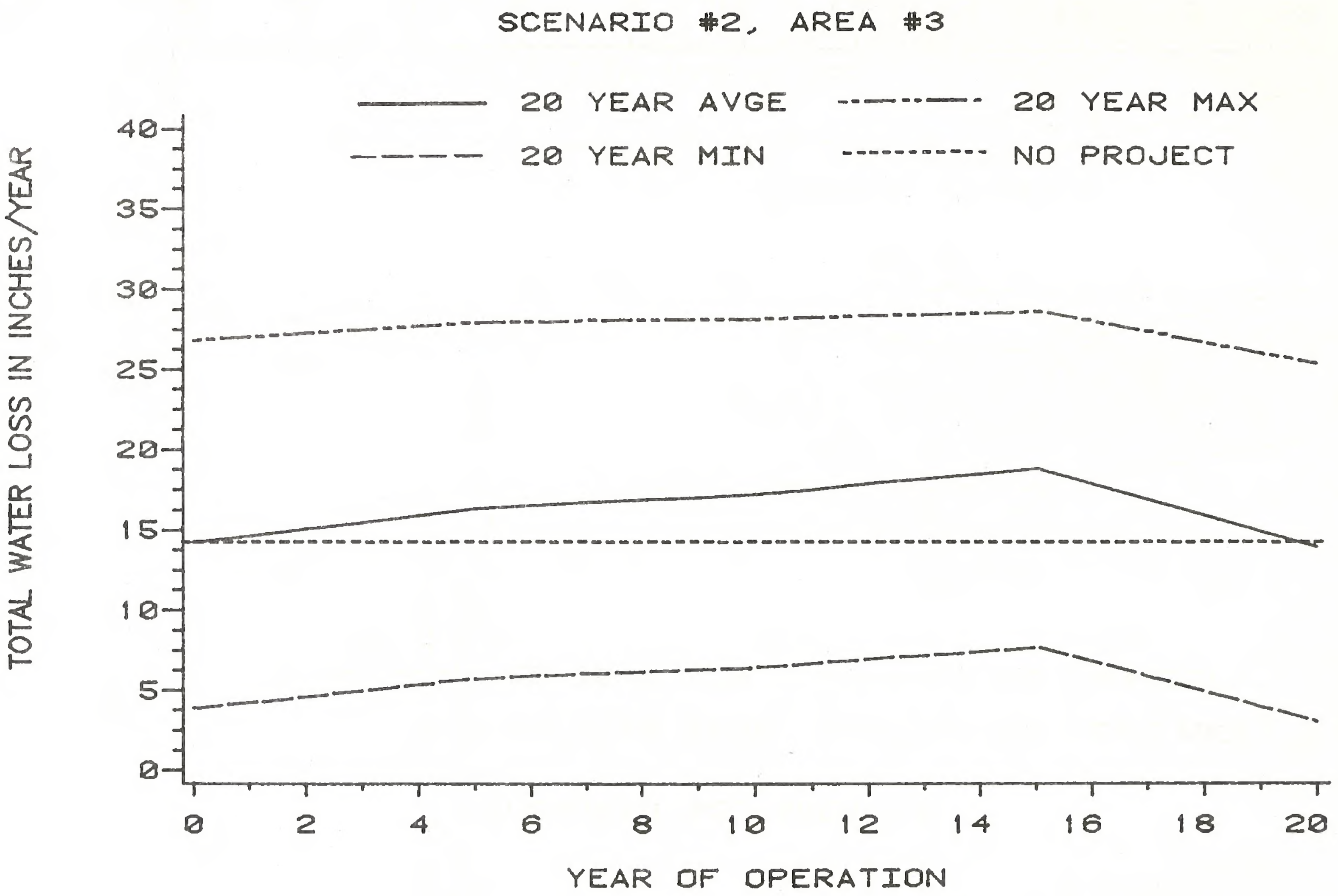


Figure 6.2.1.1E: Scenario #2, Area 3-- Total annual flow (inches per year)

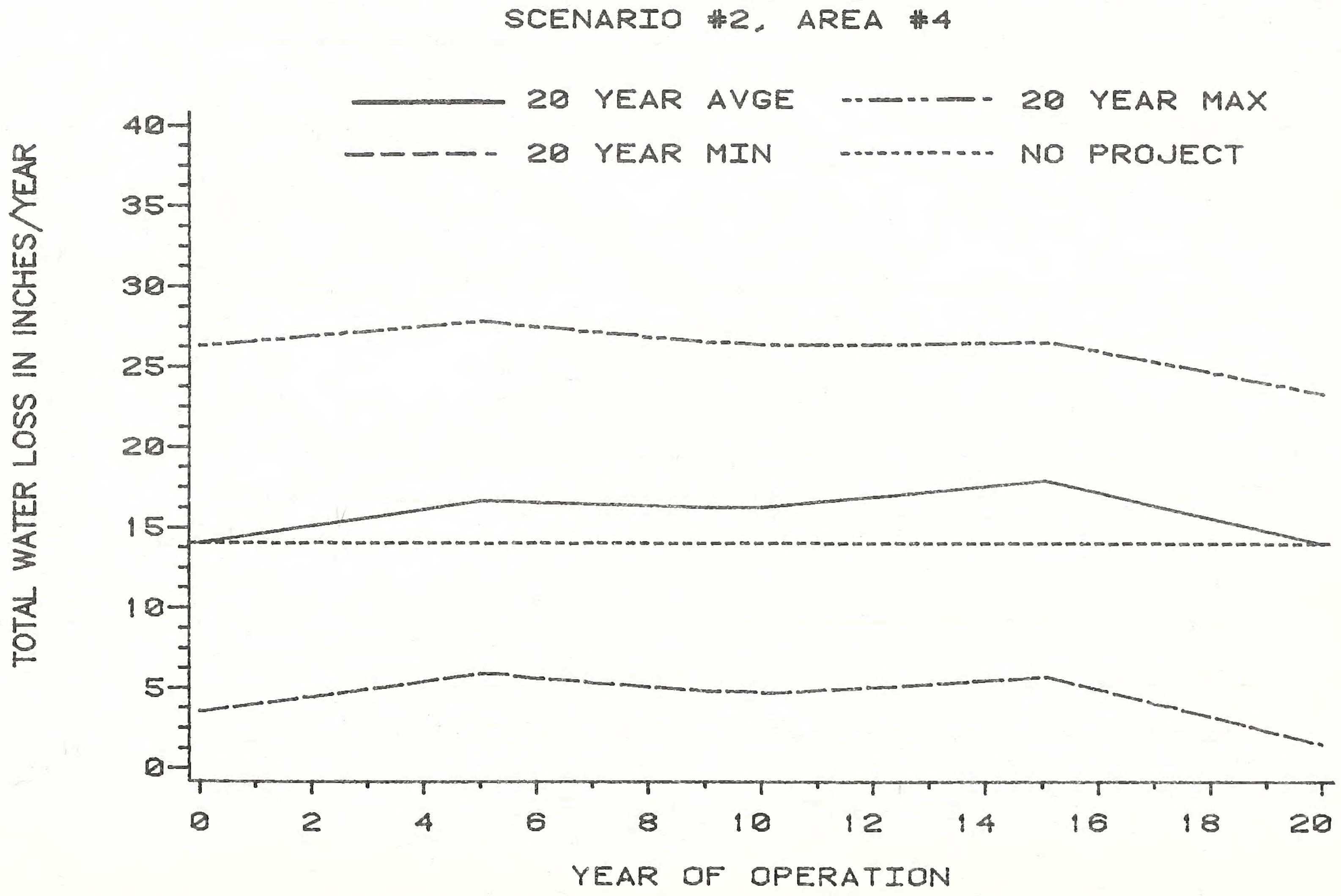


Figure 6.2.1.1F: Scenario #2, Area 4-- Total annual flow (inches per year)

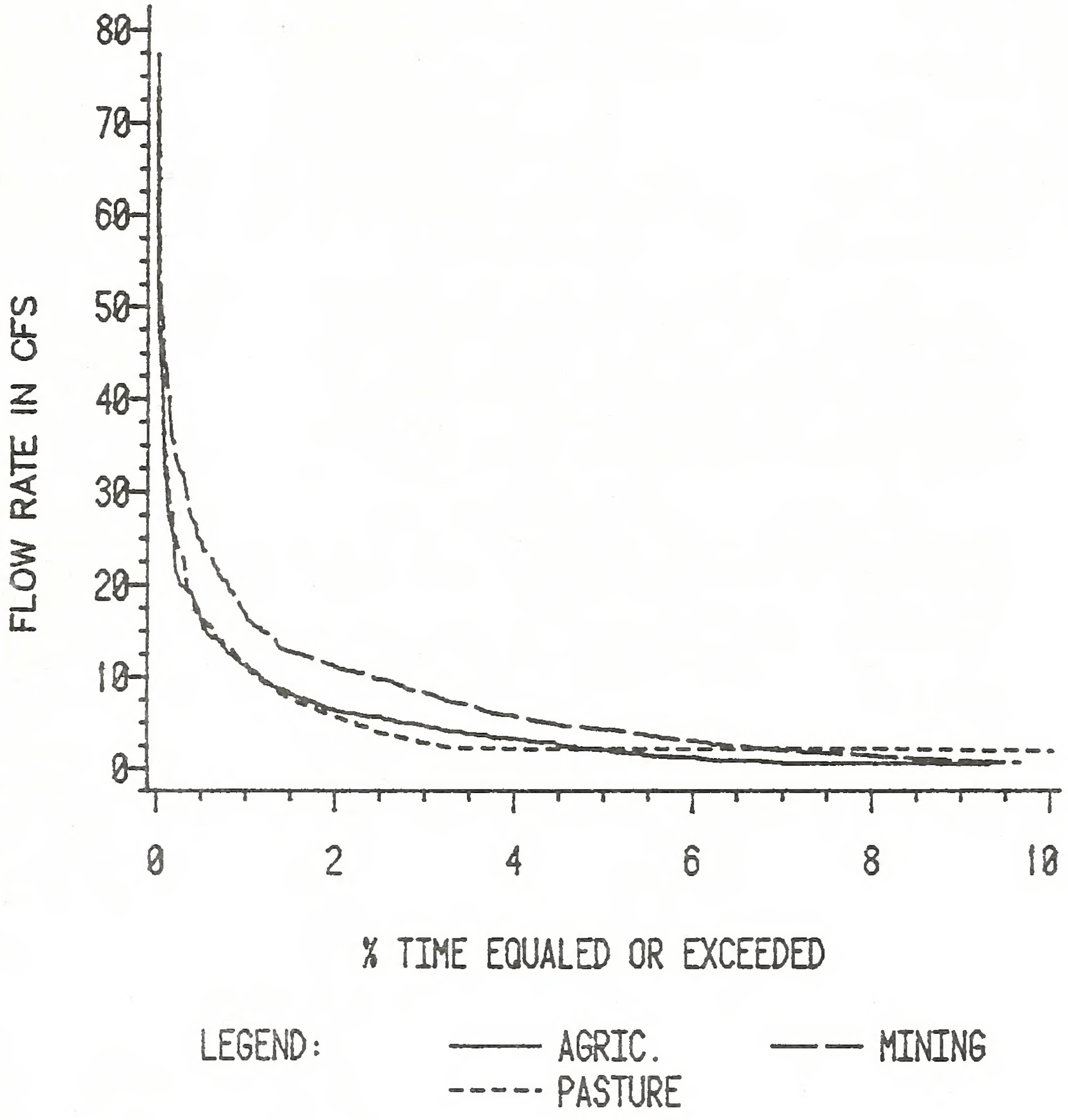


Figure 6.2.1.1G: Comparison of peak flows from a 320-acre block under three different land uses

6.2.1.1.3 Conclusions

6.2.1.1.3.1 Scenario #1

For Scenario #1, Area 1, the average annual total flow will not vary by more than about 5% from the pre-mined condition over the first 20 years of operation (see Figure 6.2.1.1A). The reasons for this small change include: 1) less than 25% of the area will be in the mined condition at one time, 2) reduced flows from the reclaimed area will off-set the increased flows from the actively mined areas and 3) the effect of extra evaporation from the lakes.

The slight steady decline in expected total annual water loss from Area 1 will continue to the end of mining (approximately year 35). At this point, the average annual flow should stabilize at approximately 14 inches per year (21% less than the pre-mining condition).

The abrupt increase in expected flow in years 9 and 10 corresponds to the abandonment of the large (8 blocks, 2560 acres) temporary lake and the sole use of the smaller (1450 acres) permanent lake. This transition need not be as abrupt as depicted; maintaining the larger lake into year 13 would clearly help reduce total annual flows.

In Area 2 of Scenario #1, the initial increase in total annual flows will be greater than for Area 1 because no lake is proposed (see Figure 6.2.1.1B). Once the maximum disturbed area has been reached, total flows will level off as the area of reclaimed land slowly increases. Again, the average flow will drop below pre-mining levels once all the mined areas have been reclaimed.

In both areas, the major factor controlling the occurrence of floods will be the capacity of the pumps removing water from the canal system to the lakes (in Area 1) and the Intracoastal Waterway (in Area 2). ESE (1983) predicted (using the SWMM III model) only two breaches of the 1450-acre lake in Area 1 over 20 years of historical climate data from 1960 to 1979. However, if water cannot be pumped into the deep storage available in the lake at a high enough rate during high rainfall events, the canals themselves may be breached, causing flooding. Because of the low lying aspect of the mined land in relation to the surrounding unmined areas, flooding should remain localized for most events. The lowered elevations due to mining will increase the capacity to store water on the surface, therefore, the occurrence of downstream flooding should be reduced from the before mining condition for all scenarios and areas with the following exception. In Area 1, the volume of flow in Canal B will slowly increase throughout the life of the peat mine until all the flow from the 15,000-acre area will be routed through the lake and discharged into Canal B. In year 35, this will amount to about 14 inches per year, or an average annual flow rate of 25 cubic feet per second (as compared to an average annual flow rate of about 31 cubic feet per second from the total area at present). Despite the overall drop in total flow, the flows in Canal B during and after rainfall events will be increased. The increased flow in Canal B will increase the risk of downstream flooding as the storage capacity of the canal is reduced. Canal B will have to be considerably deepened and maintained free from weeds and sediment to ensure rapid removal of water and lessen the risk of flooding.

There are two possible organizational mechanisms for performing the necessary deepening and maintenance of Canal B. Responsibility for maintenance of the canal could be placed with a local drainage district. Drainage districts in North Carolina are usually directed by part time volunteers and have to depend on sources of funds that are not always reliable. There is no existing drainage district covering Canal B, so one would have to be created.

The second option would be to place continuing responsibility for canal maintenance with a state agency. The work could be funded either out of general state revenues or out of the proposed severance tax revenues discussed in section 4.3.3.3. The responsibile agency would have to obtain permission from private landowners whose property is crossed by the canal to enter their land to perform the maintenance.

There does not appear to be sufficient authority in the Mining Act to require canal deepening and maintenance as part of the reclamation plan.

6.2.1.1.3.2 Scenario #2

For all areas in Scenario #2 the annual flow will be less than 30% above the pre-mining flow for all 20 years of operation. With the exception of Area 1, the flows will increase with increased acreage in active mining, then hold relatively constant until the size of the mining area starts to decline and with it the flows. In all areas the flow in year 20 will be less than or equal to the flow in year 0 as a result of higher evapotranspiration and lower flows land reclaimed to agriculture and forestry. Area 1 demonstrates the advantages of using a lake for water management: the annual flows will remain closer to the pre-mining situation. The jump in flows in year 8 in Area 1 is due to abandoning a large evaporation area for a smaller permanent lake. Maintaining the larger temporary evaporation area until year 15 will keep annual flows close to the pre-mining levels. The second main advantage of a lake system is the controlled release of flow. Storm peaks will be substantially reduced, provided lake or canal over-topping does not occur. In Area 4 the residential areas, with their high surface runoff, will counterbalance the flow-reducing effect of the lake and the annual flows will behave similarly to those in Areas 2 and 3.

Figure 6.2.1.1G illustrates the differences in peak flows that might be expected from a 320-acre block under three different land use conditions. This flow duration curve is truncated at 10% to focus on the high flows. For flows equalled or exceeded more than 10% of the time all three curves are similar. The post-mining agriculture and pre-mining pasture are also similar for flows greater than 5 cubic feet per second. The actively mined site, however, exhibits a definite increase in frequency of high flows. For example, a flow of 10 cubic feet per second will be equalled or exceeded about 1.2% of the time for pasture or agriculture, but will be equalled or exceeded about 2.25% of the time for actively mined sites.

6.2.1.1.3.3 Scenario #3

For Scenario #3 the flows up to and including year 10 will be the same as for Scenario #1. After year 10 it is assumed that all pumping ceases, that canal dams are broken and all canal and dike maintenance ceases, resulting in the creation (by year 20) of a swamp/lake area covering all mined and reclaimed areas (see sections 5.2.4.5 and 5.2.4.10). The volume and distribution of the runoff from these areas will be dependent on the changing nature of the outlets, how much water storage is available on the surface of the mined areas and the type and density of returning vegetation. Provided that the water levels remain high enough to satisfy potential evapotranspiration at all times, then the water available for runoff will be approximately equal to rainfall minus potential evapotranspiration, or an average of about 10 inches per year.

6.2.1.2 Nutrient Yields and Surface Water Eutrophication

6.2.1.2.1 Approach/Assumptions

A preliminary assessment was made of the environmental consequences of peat harvesting and subsequent conversion of some of the peat to methanol, specifically the effects upon nutrients in runoff and adverse changes in water quality. The approach to the problem and the assumptions made were:

1. Literature data on nutrient concentrations and yields from various land uses in this area (natural vegetation, cropland, pasture land, and peatland cleared for mining) were assembled.

2. Land use data used are located in Appendix 10.6 (Table 10.6A).

3. It was assumed that: 1) planted forests, buffers and natural revegetation have the same yields of nutrients as natural vegetation, 2) the whole area was ditched but in natural vegetation at year 0 and 3) open water is a source for nutrients in proportion to its area and the nutrient content of rainwater and a sink for about half of its loading of total nitrogen (TN) and total phosphorus (TP). Removal of nutrients from water passing through wetlands or buffer zones was not assessed for lack of data on hydrology.

4. The yields (lb/acre.yr) were multiplied by the areas (acres) of each land useage (see Appendix 10.6) and summed to calculate the total nutrient yield for each scenario and each area at years 0, 10 and 20, except Scenario #3 (years 0 and 10 only).

5. The total nutrient yields which drain into lagoons at years 0 and 20 were summed and divided by the area of each lagoon or lake to obtain the areal loading rate (lb/acre.yr). These loading rates were compared to rates reported to have resulted in eutrophic conditions.

6. The total nutrient loadings of estuaries contributed by runoff from areas subjected to peat mining and subsequent agricultural development were examined. It was assumed that runoff and other waters having passed through lakes or lagoons had half of the total nitrogen (TN) and total phosphorus (TP) removed. Where runoff was to the IWW, it was assumed that half of the load went to the Pungo River and half to the Alligator River. Area 1 loading rates attributable to the peat mining and associated operations (including agricultural development) were obtained by dividing by the area of each estuary. (Area was determined

by planimetry.) These loadings were then compared to the anticipated loading from the rest of the watershed and to those which have created eutrophic conditions in similar estuaries.

6.2.1.2.2 Data

Table 6.2.1.2A: Concentrations (mg/l) of nutrients in runoff water from various land uses

Land Use	Nutrient					
	NH_4	NO_3	Kjeld-N	Total N	Ortho-P	Total P
Natural vegetation, planted forests, regenerated vegetation (a,b)	0.15	0.06	1.19	1.25*	0.02	0.06*
Cleared peatland before, during, after mining (b)	0.35	0.13	1.85	1.98*	0.05	0.17*
Drained cropland (a)	0.91	1.00	2.92	3.73*	-	0.14*
Drained pastureland (c)	0.37	0.21	1.67	1.88*	-	2.48*

Note:
Abbreviations may be found in Appendix 10.10
* Hypereutrophic (Wetzel, 1975)
Sources:
(a) Skaggs et al., 1980, mineral soil
(b) Gregory et al., 1984
(c) Kuenzler et al., 1977

Table 6.2.1.2.B: Areal yields (lb/acre.yr) of nutrients from watersheds with various land uses

Land Use	Nutrient NH_4	NO_3	Kjeld-N	Total N	Ortho-P	Total P
Natural vegetation (as defined in Table 6.2.1.2A)	0.7	0.2	5.2	5.4	0.06	0.26
Cleared for mining	1.9	0.7	10.0	10.8	0.27	0.93
Drained cropland	3.3	3.6	10.0	13.5	-	0.50
Drained pasture	1.2	0.6	5.4	6.1	-	8.5
Open water	2.3	2.6	5.3	8.0	0.46	0.59
Residential	-	-	-	5.3	-	1.1

Notes:

Assumed runoff values:

1. Natural vegetation: 14.6 in/yr (Mean of shrub (16.7 in/yr) and forest vegetation (12.6 in/yr) runoff values from Table A, section 5.2.1.1, Task 2, first draft (10/14/84))
2. Cleared for mining: 24.1 in/yr (Based on active mine runoff value, Table A, section 5.2.1.1, Task 2 first draft)
3. Drained cropland: 14.8 in/yr (Based on page 17, Task 1 final draft (9/83): 6.8 inches subsurface drainage + 8.0 inches surface runoff)
4. Drained pasture: 19.2 in/yr (Based on page 17, Task 1 final draft: 11.2 inches subsurface drainage + 8.0 inches surface runoff)
5. Open water: rainwater concentrations (from Kuenzler et al., 1977) x annual precipitation (48.4 in/yr, from page 34, Task 2 final draft)
6. Residential: based on Reckhow et al., 1980

Concentrations from Table 6.2.1.2A

Abbreviations may be found in Appendix 10.10

Table 6.2.1.2C: Total annual yields of nutrients from peatlands under the alternative scenarios

Scenario #	Area #	Year	Annual Yield (Tons/Yr)			
			NH_4-N	NO_3-N	Total N	Total P
1	1	0	4.6	1.4	36	1.7
		10	7.9	> 3.8	>46	>2.9
		20	13.1	>10.5	>62	>3.3
1	2	0	2.1	0.6	16	0.7
		10	4.1	2.6	23	1.7
		20	6.7	6.0	31	1.8
2	1	0	8.6	2.5	67	3.2
		10	13.8	> 7.9	> 79	> 5.2
		20	32.8	>29.0	>135	>10.8
2	2	0	4.3	1.3	34	1.6
		10	7.2	4.6	43	2.3
		20	16.3	15.6	72	4.1
2	3	0	7.4	2.2	58	2.7
		10	12.0	> 6.7	> 72	> 4.6
		20	29.2	>25.9	>123	> 9.3
2	4	0	3.7	1.1	29	1.4
		10	5.4	3.3	33	2.1
		20	5.8	4.3	34	3.8

Notes:

Abbreviations may be found in Appendix 10.10

Scenario #3 same as Scenario #1 for Areas 1 and 2, years 0 and 10.

Total annual yields for scenarios cannot be directly compared because total acreages for areas and scenarios are different

Table 6.2.1.2D: Nutrient loadings to lakes and lagoons

Scenario #	Area #	Year	Water Body	Water Area (acres)	Nutrient Load (lb/acre.yr) TN	TP
1,3	1	10	Temp Lake	1,455	36*	1.7*
1	1	20	Perm Lake	1,455	80*	4.4*
2	1	10	Lagoons	2,907	22*	2.2*
		20	Lagoons	2,907	103*	8.6*
2	4	10	Lagoons	1,954	12.6	1.2
		20	Lagoons	2,895	21*	2.8*

Procedure:

Divide annual TN or TP loading to lagoons (= total yield - yield from forest) by lagoon or lake area.

Notes:

Abbreviations may be found in Appendix 10.10

* Exceed Vollenweider's (1968) criteria of "dangerous" loading: 18 lb TN/acre.yr or 1.2 lb TP/acre.yr

Table 6.2.1.2E: Nutrient loadings to estuaries. Approximate background loading if entire watershed were in natural vegetation and predicted loadings at years 0, 10 and 20, with assumption of 50% TN and TP removal by lagoons and canals.

Scenario #	Area #	Year	Water Body	Water Area (acres)	Nutrient Loading (lb/acre.yr) Background From Natural Watershed TN	Background From Natural Watershed TP	Loading From Project Area Alone TN	Loading From Project Area Alone TP
1	1+2	0	Pungo R.	12,000	19	.94	4.0	.20
		10	Pungo R.				4.2	.26
		20	Pungo R.				4.8	.26
1	2	0	Alligator R.	11,900	81	4.1	.74	.04
		10	Alligator R.				1.07	.08
		20	Alligator R.				1.47	.08
2	1+2	0	Pungo R.	12,000	19	.94	7.7	.37
		10	Pungo R.				8.1	.34
		20	Pungo R.				10.0	.70
2	2+3+4	0	Alligator R.	11,900	81	4.1	9.7	.46
		10	Alligator R.				11.2	.66
		20	Alligator R.				16.8	1.79

Note:
Abbreviations may be found in Appendix 10.10

6.2.1.2.3 Conclusions

Nutrient concentrations vary considerably in runoff from land in different uses (Table 6.2.1.2A). Compared to natural vegetation, planted forests and revegetated areas, disturbance by clearing for mining or for agriculture considerably increases nutrient concentrations in runoff. For example, disturbance considerably increases nutrient concentrations as follows:

1. NH_4 increased 1.7-6.1-fold by disturbance.
2. NO_3 increased 2.2-fold by mining, 2.5-fold by pastures, and 17-fold by crops.
3. Total N (TN) increased 1.6-fold by mining, 1.5-fold by pastures, and 3.0-fold by crops.
4. Total P (TP) increased 3.0-fold by mining, 44-fold by pastures, and 2.3-fold by crops.

Furthermore, nutrient concentrations in all of these waters are relatively high. The TP and TN levels in waters draining from naturally vegetated areas (Table 6.2.1.2A) would, if present in a lake, cause them to be classified as hypereutrophic (Wetzel, 1975) (see Appendix 10.6); TP levels in waters from disturbed tracts are high enough to classify them as eutrophic to hypereutrophic even by the less rigorous water quality criteria for North Carolina waters suggested by Weiss and Kuenzler (1976).

The areal nutrient yields (lb/acre.year) from land in different uses is a function of both the nutrient content of the runoff and the amount of runoff (Table 6.2.1.2B). Lowest yields generally came from areas in natural vegetation and highest yields from areas used for mining or agriculture. The increased yields of N from North Carolina peatlands under various changes in land use are similar to the increases seen in other watersheds used for these purposes (see figures from Reckhow, et al., 1980 in Appendix 10.6). There is large variability in export coefficients for the same land use (Appendix 10.6) because measurements include tracts with different soils, different slopes, different nutrient inputs (fertilizer, manure, septic tank drainage) and different amounts of runoff. Data gathered by Skaggs et al. (1980) and Gregory et al. (1984) showed areal yield of P from non-organic cropland (0.55 kg/ha.yr) below the lower quartile of data gathered by Reckhow et al. (1980) (Appendix 10.6) whereas yield from organic soil (7.6 kg/ha.yr) was above Reckhow's upper quartile. The lower yield estimate (0.55 kg/ha.yr) was used in calculations for this report under the assumption that crops will be grown only on a highly mineral soil remaining after mining has removed the peat. The much higher yield of P from pasture on North Carolina peat soils than were reported by Reckhow et al. (1980) are consistent with the usually poor retention of P by peat. Nitrogen yields from North Carolina cropland and pastures were closer to Reckhow's medians (Appendix 10.6), although N yields from the state's forest lands were near the top of his range.

Total annual yields (Table 6.2.1.2C) will increase in each scenario and area from year 0 to year 20. Comparison of yields between scenarios, however, must take into account the larger total area considered in Scenario #2 than in Scenarios #1 and #3. Total annual yields of NO_3 increase by the largest percentage (always >4-fold). Increases in TN from disturbed lands result mostly from increases in ammonium and nitrate rather than from organic N; this is important because ammonium and nitrate are readily available for algal growth. The yield of TP also increases substantially, from 2- to 3.4-fold, depending on the area. This analysis does not include loading of P leached from solid wastes of the methanol plant(s). Conversion of 525,000 tons of peat per year at 0.04% P would result in 210 tons of P in ash, slag and other forms, at least 20 times more than the annual yields of any one area in any scenario (Table 6.2.1.2C). Therefore, if substantial amounts of phosphorus are leached within the watershed from disposal in landfills or on agricultral lands as a soil conditioner and thereby enter surface waters, P-loading to lagoons will greatly increase over the loadings calculated here.

Predicted nutrient loadings to lakes and lagoons (Table 6.2.1.2D) exceed Vollenweider's criteria of 18 lb N/acre.yr and 1.2 lb P/acre.yr at both years 0 and 20 in virtually all scenarios. The criteria of Vollenweider are not strictly applicable to North Carolina's surface waters, especially the relatively dystrophic waters of the Outer Coastal Plain, but the fact that calculated loadings are several to many times Vollenweider's criteria suggests that severe problems are likely. Eutrophic waters with dense algal growths may be expected, but precise estimation cannot be made without detailed information on algal densities which result from various nutrient loadings in similar lagoons in this region of North Carolina.

The Pungo and Alligator Rivers have nearly the same surface areas (Table 6.2.1.2E), but the background nutrient loading rates to the Alligator River are about four times higher because its watershed is that much larger. Under natural conditions these loads are probably well distributed spatially and the poor light transmission by the dark and turbid waters prevents high algal productivities. The Alligator River did not show abundant phytoplankton ten years ago (Bowden and Hobbie, 1977). Recent measurements of nutrient concentrations (PMA, 1982c) show that the Pungo River is now rich in nutrients. Estuaries act as nutrient traps, especially for P, often being substantially richer in total P than any of their source waters. This is clearly seen in the high P concentrations and algal abundances during summer in the middle reaches of the Pamlico River (Kuenzler et al., 1979), the source of salt water for the Pungo River. Background P loadings of 0.94 and 4.1 lb/acre.yr for the Pungo and Alligator Rivers, respectively, are at or above the Vollenweider criterion, but they are at least an order of magnitude less than present loadings of the Pamlico and Chowan Rivers because these latter rivers have considerably larger watersheds. Both Weiss and Kuenzler (1976) and Craig et al. (1977) suggest that Coastal Plain systems of the Southeast may function without noxious algal blooms even with P loadings several fold higher than the Vollenweider criteria. This suggestion is borne out by conditions in the Pamlico River; productivity of the phytoplankton is high but noxious algal blooms have not occurred in the brackish portions. Dispersion of P-rich water from downstream and regeneration of P from the sediments or the estuarine fauna constitute additional loadings not included in this analysis.

The emphasis here has been on phosphorus, in large part because this element is more often limiting in lakes. The data in Table 6.2.1.2E show TN:TP ratios usually about 20:1 by weight; such ratios are close to the proper ratio for algae. Furthermore, any N loads resulting from the mining and subsequent land development will be in addition to loads which are at or far above the Vollenweider criterion of 18 lb N/acre.yr.

Because of their large areas relative to the developed areas in the scenarios, activities associated with and following mining will not deliver to the Pungo and Alligator Rivers nutrient loads which are large compared to the "background" loads (Table 6.2.1.2E). As stated above, leaching of nutrients from ash, slag or other solid wastes from a potential methanol plant has not been evaluated and could increase loadings several fold over the values shown for the mining projects alone. The areas proposed for mining, however, are only a portion of each estuary's watershed, 40% and 12% for the Pungo and Alligator Rivers, respectively. Additional extensive land development, for agriculture or other purposes, will impose additional nutrient loads on the estuaries, especially if lagoons or wetland buffer strips are not used to strip nutrients from land runoff.

It appears that the Alligator River is more at risk because of its greater natural load and the anticipated greater load due to development for any particular scenario. If half of the Alligator River watershed undergoes development which yields P at the average rate of the mined areas, the anticipated load would reach about 7 lb P/acre.yr. The work of Jaworski (1981) suggests that in estuaries with N:P ratios of 7.2:1 (by weight) excessive eutrophication may result if P loadings exceed 9 lb/acre.yr. Thus the whole Alligator River may be at risk with less than complete development of the watershed; periodic nutrient pulses to the fresher, poorly mixed headwater areas could result in eutrophic conditions with still less development. The fresher waters are considered to be at more risk because certain blue-green algae can form surface blooms in these areas in summer.

In view of 1) present water quality of the Pungo and Alligator Rivers; 2) their background loadings from the watershed and by dispersion upstream; 3) the additional loading from existing agriculture and other land development not included in this analysis; and 4) the intensive agricultural development now being planned on the eastern shore of the Alligator River, additional loadings such as have been calculated from these scenarios are a threat to future water quality. Since mixing is not uniform, excessive loadings of P (and maybe N) to the upper portions of these estuaries will almost certainly result and eutrophic conditions may be expected. However, there are no accepted criteria specifically for estuarine waters of North Carolina or the Southeast and "dangerous" loadings may not be the same as suggested by Jaworski for other estuaries.

Lee and Jones (1979) extended the Vollenweider P-loading relationship to estuarine waters and found that data from the Potomac Estuary fell into the eutrophic sector of the diagram, as expected. The principle behind this relationship is the same for estuaries as for freshwater lakes where it was developed, but larger amounts of P may be assimilated in estuaries without resulting management problems. Although there are considerable uncertainties in the data and the assumptions of this analysis, recent appearance of severe algal blooms in the slightly brackish portions of the Chowan River and the Neuse River suggests that the upper reaches of other North Carolina estuaries are in danger if nutrient loadings are not carefully controlled.

6.2.1.2.3.1 Summary

Examination of the data on nutrient yields from North Carolina peatlands under various kinds of land use suggest that mining of the peat, production of methanol and placing the land in agricultural production may have an adverse impact on water quality. The natural vegetation yields less N and P per unit area than other land uses, usually by a large factor; therefore, conversion to other uses results in loss of nutrients to downstream aquatic systems. The lagoons and lakes into which runoff and plant effluents may run or be pumped probably will become unacceptably eutrophic. Unless these lagoons and buffer wetland systems efficiently remove nutrients from the water as it passes through, there will also be substantial nutrient loading of the Pungo River and the Alligator River and consequent eutrophication.

This assessment cannot be made more accurately with the present data base and time resources, but the indications are that serious water quality degradation may result from the changes in land use and from associated industrial development in this region.

6.2.1.2.3.2 Regulatory Implications and Options for Controlling Nutrient Loading

To the extent that these nutrients are entering "waters of the United States" from canals and ditches, i.e., point sources, they can be controlled through the NPDES permit. Any nutrients entering waters from general runoff, i.e., non-point sources, are not subject to any control mechanism; however, the state 208 plan urges that best management practices be used to control this type of runoff.

Another possibility is for the Environmental Management Commission to classify the affected waters as nutrient sensitive under G.S. 143-214.1. Once waters have been so classified, however, the enforcement mechanism by which standards are imposed to meet the classification is uncertain. In some cases, the state is able to use a special order under G.S. 143-215.2, but agricultural and forestry activities are expressly exempted from the reach of special orders. Another enforcement approach is to attempt to equate the nutrient sensitive classification with water quality limited waters under 33 U.S.C. section 1312, thereby authorizing the imposition of more stringent effluent limitations through the NPDES process than would be imposed under the 33 U.S.C. section 1311 effluent standards. This still does not deal with the problem of non-point sources, however.

A third possible legal source for controlling nutrients is the mining permit itself. Among the grounds for denying a permit under G.S. 74-51 are that the operation will have unduly adverse effects on freshwater, estuarine or marine fisheries, or that the operation will violate water quality standards promulgated by NRCD. If the excessive nutrient levels would trigger either of these provisions, the permit conditions should reflect controls to reduce the nutrients to acceptable levels. The use of the mining permit to control nutrients has the advantage of imposing enforceable controls on non-point sources.

6.2.1.3 Trace Element, Pesticide and Coliform Bacteria Yields

6.2.1.3.1 Approach/Assumptions

The approach followed that employed in section 6.2.1.2 Ten elements were selected for study based on occurrence in peat and environmental concern (dictated largely by relative toxicity):

Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Lead (Pb)
Mercury (Hg)
Manganese (Mn)
Nickel (Ni)
Selenium (Se)
Zinc (Zn)

A review of the available literature indicated the following:

1. For As, Cd, Cr, Ni and Se only "less than detectable" data are available.

2. No data are available for the ten elements (excluding largely "less than detectable" data for Hg) for the land use category "actively mined".

3. Data suitable for predicting changes due to land use changes (i.e., from undeveloped peatlands to croplands or pasture lands) are available only for Cu, Mn and Zn (Skaggs et al. 1980).

Therefore, yields for Cu, Mn and Zn were calculated following the assumptions and procedures used in section 6.2.1.2. Since no data pertaining to yields associated with either active mining or residential development were found, it was assumed that yields from these two sources are equivalent to yields from shallow organic croplands according to Skaggs et al. (1980). In addition, yields from open water were assumed equivalent to yields from naturally vegetated areas. The use of the relatively low yields reflects the assumption that open water areas will serve as a partial sink for metals from surrounding peat mines and croplands. The following yields from Skaggs et al. (1980) were used:

Source	Yields (lb/acre.yr)		
	Cu	Mn	Zn
Deep organic, naturally-vegetated peat	0.062	0.018	0.071
Deep organic pasture	0.027	0.089	0.071
Shallow organic croplands	0.125	0.107	0.259

Land use data used are located in Appendix 10.6 (Table 10.6A).

Yields from the effluent of a peat-to-methanol conversion plant were calculated based on data from PMA's NPDES application (PMA, 1983f). The assumption was made that the flow rate and element concentrations given in this document (0.866 mgd) are equivalent to those associated with the processing of 500,000 dry tons of peat per year, as stated in Scenario #1, Area 1. Effluent yields for other areas and/or scenarios were prorated according to estimates of peat processed for methanol given in the scenarios (see sections 5.2.2.3.3, 5.2.3.3.3 and 5.2.4.3.3).

6.2.1.3.2 Data

Table 6.2.1.3A: Total annual yields of three trace elements in drainage waters from peatlands under alternative scenarios

Scenario #	Area #	Year	Annual Yield (lb/yr) Cu	Mn	Zn
1	1	0	981	285	1123
		10	1212	611	1811
		20	1504	1024	2685
1	2	0	443	129	507
		10	609	368	1007
		20	755	581	1449
2	1	0	1860	540	2130
		10	2050	842	2726
		20	3136	2491	6067
2	2	0	930	270	1065
		10	1125	552	1652
		20	1696	1382	3376
2	3	0	1612	468	1846
		10	1890	885	2697
		20	2883	2389	5747
2	4	0	806	234	923
		10	859	315	1086
		20	1092	663	1798

Notes:

Scenario #3: same as Scenario #1, Areas 1 and 2, at years 0 and 10.

Assumed runoff values: same as for Table 6.2.1.2B

Table 6.2.1.3B: Total annual yields of selected trace elements from wastewater effluent discharged by methanol plants in the scenarios (lb/yr)

Scenario #	Area #	Year	Element					
			Se	As	Cd	Mn	Ni	Zn
1 & 3	1	0	0	0	0	0	0	0
		10	2.6	7.9	2.6	52.7	184.3	237
		20*	2.6	7.9	2.6	52.7	184.3	237
2	1	0	0	0	0	0	0	0
		10	4.2	12.6	4.2	82.9	290.2	373.3
		20	12.6	37.5	12.6	248.9	871	1120.1
2	3	0	0	0	0	0	0	0
		10	2.4	7.5	2.4	49.8	174	223.8
		20	9.3	28	9.3	185.4	648.3	833.5

Notes:
*Scenario #1 only
For other areas in all scenarios no processing of peat on site

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Table 6.2.1.3C: Average fecal and total coliform bacteria concentrations measured in drainage water from the organic soil sites (no./100ml)

	Shallow Organic				Deep Organic			
	Crop		Natural		Pasture		Natural	
	Fecal	Total	Fecal	Total	Fecal	Total	Fecal	Total
1976*	28	1665	29	441	730	2672	18	132
1977	207	1091	9	139	1242	2665	5	71
1978	193	2054	28	313	1181	2231	17	117

Note:
*Only monitored for last six months of the year. The averages are not weighted averages, but are means of all values obtained, regardless of flow rate.

Source:
Skaggs et al., 1980

6.2.1.3.3 Conclusions

6.2.1.3.3.1 Trace Elements

Generally, increases in Cu, Mn and Zn appear to reflect conversion of peatlands to croplands, which is not surprising given the yield data provided by Skaggs et al. (1980) and recalling the equivalence of actively mined areas and croplands. Trace elements, particularly those that occur predominantly as divalent cations (e.g., Cd, Hg, Ni, Pb) will probably display trends similar to those suggested here for Cu and Zn.

Among the trace element components of methanol plant effluent (Table 6.2.1.3B), the significant quantities of Ni anticipated may merit particular scrutiny. Unfortunately, no data concerning organic constituents of such plant effluent are available; such data are necessary to fully assess potential impacts of the effluent.

The potential impacts of trace element yields have not yet been considered due to severe data limitations and current time constraints.

6.2.1.3.3.2 Pesticides

There are far less data available concerning yields of pesticides in the region than exist even for trace elements. However, runoff containing pesticides from peatlands converted to croplands could have impacts on receiving systems. Yields have been estimated, to our knowledge, only for Alachlor, the most widely used herbicide in the region. According to Skaggs et al. (1980), less than 1% of the amount applied will enter surface waters, based on field experiments. Using an average application rate of 3 lbs/ac (3.4 kg/ha) suggested by Dr. John W. Van Duyn (state entomologist, Plymouth, NC), the following yields can be estimated:

Low	Medium	High
(0.1%)	(0.5%)	(1.0%)
0.0030 lb/ac.yr	0.0151 lb/ac.yr	0.0303 lb/ac.yr

At this point, this is as far as the analysis can go, since we have no estimates of the proportion of peatlands expected to be converted to croplands that will be treated with Alachlor. It should be noted that Skaggs et al. (1980) observed concentrations of Alachlor in drainage waters on two occasions that were within the 95% confidence interval of the LD_{50} for bluegill (2.33-4.5 μg/ml (Johnson and Finley, 1980).

Other pesticides currently in use in the area and the crops on which they are used may be found in Appendix 10.7. Yield estimates provided by Willis and McDonald (1982) may be useful for predicting inputs of some of these pesticides where application areas and rates can be predicted.

6.2.1.3.3.3 Coliform Bacteria

Again, data are quite sparse and appear inadequate for making yield predictions. However, the following concentration data from Skaggs et al. (1980) clearly indicate the potential for large increases in inputs of coliform bacteria from peatlands converted to croplands and, particularly, to pasture. The potential impacts of such inputs have not yet been assessed.

6.2.1.3.3.4 Summary

The limited data available suggest that peat mining activity and subsequent land use changes will significantly increase effluxes of trace metals, pesticides and coliform bacteria. At this time, little information exists to address the critical question of the impacts of such increases in drainage waters on biota of the receiving estuarine systems. Determining the potential for impacts is a critical research need. In addressing these issues, the approach should be similar to that employed for assessing impacts of complex effluents. If impacts do occur, they are not likely to be the result of a single material, such as mercury or Alachlor, but rather the result of the cumulative effects of a variety of trace metals, pesticides and other substances.

6.2.2 Groundwater

6.2.2.1 Approach/Assumptions

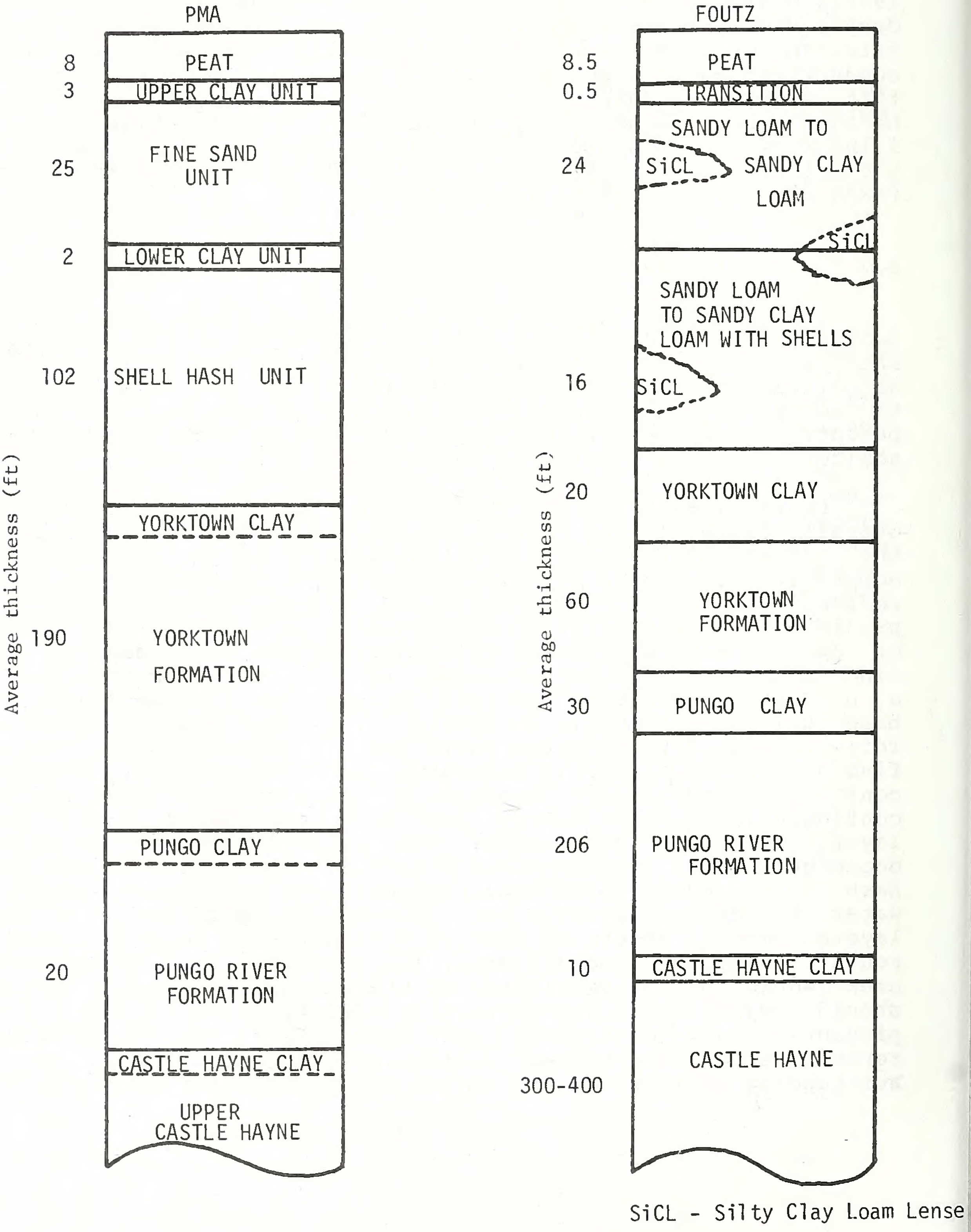
Prior to mining, the estimated recharge rate to the Castle Hayne Aquifer is between approximately 0.01 and 0.02 inches per year in the vicinity of Area 1 in Scenario #1 (Foutz, 1983). Confining clay layers over the Yorktown, Pungo River and Castle Hayne Aquifers are responsible for this very low recharge rate. These confining layers typically possess hydraulic conductivities of less than 2×10^{-4} feet per day. It is assumed that similar recharge rates exist for much of the study area because of these same confining layers. Figure 6.2.2A illustrates two approximate hydrogeologic profiles within the vicinity of Area 1 of Scenario #1 as reported by two independent researchers (PMA, 1983k; Foutz, 1983).

6.2.2.2 Conclusions

As detailed in the alternative scenarios (see sections 5.2.2.5.13, 5.2.3.5.13 and 5.2.4.5.13) the reduction in recharge rate to the Castle Hayne Aquifer with the removal of peat was determined to be less than 10%. The study area does not appear to be a major recharge area for the primary aquifers and the potential effects of peat mining on the recharge and on the aquifer yield are considered to be negligible.

Foutz (1983) found that, with the removal of peat, the overall downward gradient was maintained, although reduced from the before mining levels, in the vicinity of the PMA peat mine. However, this result may not be applicable to other areas in the region. Leggette, Brashears and Graham, Inc. (LBG, 1983) predicted, using a three-dimensional ground water model, a flow of up to 0.6 mgd being released from the shell hash and fine sand units into the surface water system. This flow results from a predicted gradient reversal between the fine sand and shell hash units resulting in an upward rather than downward gradient. This result differs from Foutz (1983), reported above. The LBG finding of upwelling is dependent upon the assumption that the confining clay layers above and below the fine sand unit are continuous. In the boring analysis performed by Foutz, these layers were not continuous. The upwelling prediction is also dependent upon the conductivities of the fine sand and shell hash units being high enough to maintain an adequate supply of water to those layers. LBG reported conductivities of these layers several orders of magnitude higher than those measured by Foutz. Based on Foutz's data, the upwelling in the PMA harvest area would be overestimated by LBG and the underlying aquifers should adjust to a new equilibrium fairly quickly after mining, preventing any continuous upwelling effect. The LBG conclusion represents a worst case situation in which heads in the surrounding aquifers do not adjust to the changing conditions.

Figure 6.2.2A: Generalized hydrogeologic units in Scenario #1, Area 1. Average thicknesses for each layer (in ft.) as reported by PMA (1983K) and Foutz (1983). Not to scale.



The potential for saltwater intrusion is of concern due to the proximity of the study area to the coast. According to Heath (1975) the fresh/saltwater interface is moving to the west. Within the Upper Castle Hayne Unit the rate of lateral movement is estimated to range from about 5 feet per year to about 15 feet per year for a change in gradient of one foot per mile (PMA, 1983k). Declines in the hydraulic head in the Upper Castle Hayne Unit project by PMA as a result of peat harvesting will result in negligible impact on the rate of interface movement. In addition, the methanol plant in Scenario #1, Area 1 will withdraw up to 3 million gallons of water per day (mgd) from the surficial aquifers for plant site dewatering during plant construction (approximately 2 years) and a maximum of 2.3 mgd from high-yielding aquifers for plant processing water during normal operation. The effects of these direct withdrawals on the fresh/saltwater interface are unknown.

A second hazard relating to salt water is the potential of upconing. Heath (1975) estimated the depth to the fresh/saltwater interface at between 400 and 600 feet. Because of the higher specific gravity of salt water and provided that the rate of movement of the fresh/saltwater interface is low, then, to maintain hydrostatic equilibrium, about 40 feet of fresh water is required below sea level for each foot of fresh water above sea level. This is known as the Ghyben-Herzberg principle. However, because of the variabilities in the formation layers in this area, this simple relationship will not be sufficient to determine the depth to the saltwater interface or its potential intrusion into the freshwater aquifers. Theoretically, a one foot decline in the pressure head in the Upper Castle Hayne Aquifer could raise the fresh/saltwater interface 40 feet. The Castle Hayne Aquifer in Areas 3 and 4 of Scenario #2 is known to be brackish and any pumping from deep aquifers in those areas may cause an upconing of brackish water sufficient to pollute production and local wells.

The probability of these problems occurring increases with proximity to the shoreline and with decreasing ground elevation. Special care should be taken in areas where mining will reduce the ground surface close to or below sea level (Scenario #1 and #3, Area 2 and Scenario #2, Areas 2, 3 and 4). The salt content of the Intracoastal Waterway and Alligator River mouth varies between 1 and 4 parts per thousand (J. Reed, Dept. of Zoology, NCSU, personal communication). Fresh water is generally considered to have a salt content of less than 0.36 parts per thousand. Thus any encroachment of these waters into local fresh water wells would cause contamination.

LBG (1983) analyzed the effects of expected alterations in hydraulic heads of various formations with peat mining. These analyses indicate that peat mining will have a negligible effect on the recharge and yield of the major aquifers and on the saltwater interface. However, analysis is lacking on the effects of direct groundwater withdrawals for plant processing. The exact magnitude of the effects of plant process water withdrawals of about 2.3 mgd (Scenario #1, Area 1) and the cumulative effects of direct withdrawals and peat mining are unknown. The analysis should also be expanded to the other areas in the study and the potential for saltwater intrusion should be studied more seriously, especially in areas where mining close to and below sea level is being considered.

To the extent that saltwater upconing becomes a problem, controls on pumping and drainage could be imposed in those areas through mining permit conditions.

6.2.3 Hurricane Flooding

Maps of the 100-year floodplain for the counties in the study area are being prepared for the National Flood Insurance Administration, but were not available at the time this report was written.

6.3 Land Use Conversions

6.3.1 Approach/Assumptions

Wetland development in North Carolina has been concentrated on tracts of land underlain by mineral soils, peaty mineral soils and shallow, high-ash peats. In all of the state's wetlands that contain peat deposits, most disturbance, including ditching, draining and clearing for either agriculture or silviculture, stops where the peat attains a thickness of about four feet. Once this thickness is reached, the degree of difficulty in preparing the land increases significantly. Outlined below are the steps typically taken to prepare a site for farming:

1. Cut out the marketable timber.
2. Dig field ditches to drain the surface and shallow subsurface water.
3. Bulldoze the remaining vegetation and root mat into windrows.
4. Bulldoze the excessive peat into the windrows.
5. If the remaining peat contains abundant "fossil" wood, pull the wood out and add it to the windrows.
6. Burn the windrows.
7. Deep plow the remaining peat into the underlying mineral soils.
8. Grade the ground surface to attain the proper slope for surface and shallow subsurface drainage.
9. Fertilize and plant.

Numerous problems are encountered in developing peat deposits as peat thickness increases. These problems can occur at any point during site preparation, as illustrated in the following examples:

1. Virgin timber was removed from most of the peatlands many years ago. The second growth that now covers a large portion of the deep peats in Hyde, Tyrrell and Washington Counties is relatively young, and is thus less attractive for commercial use.

2. The peat associated with the Alligator River predominantly fills tributary valleys of the river system. The thicker peats are concentrated in the channel areas of the valleys. Surface and subsurface waters, unless cut off by canals, still flow toward these ancestral channels. These areas, therefore, are naturally wetter than the shallow peats around the periphery of the deposits, and are thus more difficult to drain.

3. It is difficult to run heavy machinery designed for clearing and farming operations over the thick peats, especially after the supportive root mat is removed.

4. The thicker peats contain greater amounts of large wood fragments, including large stumps and logs, making the peat more difficult to prepare for use.

5. The thicker peats are typically low in ash (mostly less than 10% and commonly less than 5% ash at dry weight) and are thus nutrient poor.

6. Even with field ditching and evapotranspiration, the water table in the thicker peats remains close to ground surface, and very rarely drops into the underlying mineral soils during the growing season. The underlying mineral soils, therefore, remain out of reach of most plants.

Numerous small scale attempts, and one major attempt within the boundaries of Area 1, Scenario #1, have been made to utilize the thicker peats, but all attempts have thus far failed. By virtue of their inaccessibility, these peatlands have remained undisturbed. Peat mining may, however, eliminate practically all the major obstacles that have thus far prevented development of deep peatlands.

6.3.2 Data

Table 6.3A: Scenario #1, Areas 1 and 2-- Land use/land cover, pre- and post-mining (% of total acreage)

Land use	Area 1 Pre Yr 0	Area 1 Post Yr 20	Area 2 Pre Yr 0	Area 2 Post Yr 20
Agriculture/ Silviculture	18	72	15	88
Severely disturbed	56	0	16	0
Undisturbed/ Minimally disturbed	24	10*	69	10*
Open water	2	18	0	0
Pasture	0	0	0	2

*Restored native vegetation

Table 6.3B: Scenario #2, Areas 1, 2, 3 and 4-- Land use/land cover, pre- and post-mining (% of total acreage)

Land use	Area 1 Pre Yr 0	Area 1 Post Yr 20	Area 2 Pre Yr 0	Area 2 Post Yr 20	Area 3 Pre Yr 0	Area 3 Post Yr 20	Area 4 Pre Yr 0	Area 4 Post Yr 20
Agriculture/ Silviculture	9	73	8	88	0	85	2	18
Severely disturbed	34	0	3	0	3	0	6	0
Undisturbed/ Minimally disturbed	57	10*	89	10*	97	10*	92	18*
Open water	0	12	0	0	0	0	0	40
Pasture	0	5	0	2	0	5	0	2
Residential	0	0	0	0	0	0	0	22

*Restored native vegetation

6.3.3 Conclusions

6.3.3.1 Scenario #1

6.3.3.1.1 Area 1

The peat mines described encompass 15,818 acres. Currently 76% of this tract is severely disturbed or is in human use (Table 6.3A). Only 24% can be considered in a natural to near-natural state. Reclamation as outlined in section 5.2.2.10 will include using 72% of the area for agricultural purposes and 18% as an open water lake. Only 10% will return to a native system.

6.3.3.1.2 Area 2

The peat mine covers 7,142 acres. Currently 31% of this tract is severely disturbed or is in human use, whereas 69% can still be considered in a natural state, or has undergone only minimal disturbance (Table 6.3A). Reclamation as outlined in section 5.2.2.10 will convert this tract almost exclusively to agriculture and pasture (90%). Native vegetation will be regenerated on only 10% of the tract.

6.3.3.2 Scenario #2

6.3.3.2.1 Area 1

The total area covers 30,000 acres. In its present state, 43% of this land is in agriculture, is planned for agriculture, or is severely disturbed by human activity (Table 6.3B). The undisturbed 57% is dominated by pocosin wetlands (low pocosin=44%, high pocosin=13%). Reclamation for this tract as outlined in section 5.2.3.10 is 78% in pasture, row crops and pine plantation. An open water lake will cover 12% of the tract. Only 10% will be returned to native vegetation.

6.3.3.2.2 Area 2

Of the 15,000 acres in this tract, only 11% is severely disturbed (Table 6.3B). The 89% that is either undisturbed or minimally disturbed is covered with evergreen forest (8%), mixed swamp forest (3%), high pocosin (18%), low pocosin (48%) and partly disturbed land (12%). The reclamation plan outlined in section 5.2.3.10 will convert 90% of the land to pasture, row crops and pine; 10% will return to native vegetation.

6.3.3.2.3 Area 3

The 26,000 acres in this area are currently 97% undisturbed (Table 6.3B). Only 3% is considered transitional, containing field ditches. The undisturbed portion is dominated by high pocosin (60%). The remaining land is covered with mixed swamp forest (21%) and low pocosin (16%). Post-mining use outlined in section 5.2.3.10 will convert 90% of this land to pasture, pine plantation and row crops, with 10% returning to native vegetation.

6.3.3.2.4 Area 4

This area contains 13,000 acres, of which 92% is relatively undisturbed (Table 6.3B). Only 8% has been either cleared for farming or field ditched. Of the undisturbed land, 5% has been partially ditched. The remaining 88% contains 1% white cedar forest. Area 4 is elevationally lower than the other three areas in Scenario #2. Significant drainage problems could develop if the mined land were reclaimed in row crops. Reclamation assumed for Area 4, however, includes 40% open water, 22% residential or recreational use, 20% pasture and pine plantation and 18% restored native vegetation.

6.3.3.3 Summary

The major overall change in land use due to the scenarios will be the loss of large tracts of natural, relatively undisturbed wetlands. The subsequent post-mining maintenance of this land for agricultural purposes will prevent the land from reverting to a natural system.

Hyde, Tyrrell and Washington Counties contain a total of 876,160 acres of land, of which 205,820 (23.5%) was in active agriculture in 1981 (Lukin and Mauger, 1983). The maximum amount of peat mining, as proposed in Scenario #2 (84,000 acres), constitutes 9.6% of the land in the three county area. If the post-mining reclamation plans outlined in Scenario #2 (see section 5.2.3.10.3) are followed, an additional 40,900 acres of crop land will be developed, bringing the total agricultural land to 28.2% of the total land area in the three counties.

Approximately 84,000 acres of peat in Scenario #2 exists in deposits at least four feet thick; the entire state contains about 200,000 acres of wetlands underlain by peat of these thicknesses. The excavation of these 84,000 acres will eliminate 41% of this type of wetland environment. The dominant undisturbed land cover for the total 84,000 acres in Scenario #2 is pocosins (54,000 acres or 65%). If the disturbed pocosin land is included (13,780 additional acres), pocosins cover 68,080 acres (81%) of the total mining area in Scenario #2. Richardson, et al. (1981) state that North Carolina originally contained 2.24 million acres of pocosins, of which, by 1979, only 695,000 acres were still undisturbed and 808,000 acres were in transition. The 68,080 acres of total pocosin land in Scenario #2 constitute 4.5% of the total remaining pocosins in the state; the 54,300 acres of undisturbed pocosins include 7.8% of the state's undisturbed pocosins. Superficially, this amount does not sound like a significant portion of the total pocosin ecosystem in North Carolina. The pocosins of the Albemarle-Pamlico Peninsula, however, and in fact, the total wetland system of the peninsula, constitute the largest and least disturbed wetland complex in the state. The elimination of 84,000 acres from the core of this system will not only destroy this portion of the wetlands, but will also aid, indirectly, in the conversion of many tens of thousands of additional acres of wetland around the periphery of the wetland complex.

6.3.3.3.1 Legal Aspects of Residential Development

Legal controls exist at the federal, state and local levels to mitigate environmental harm from large-scale residential development as proposed in Area 4, Scenario #2. If the area affected is within the Section 404 permit jurisdiction, a dredge and fill permit must be obtained from the Corps of Engineers before any dredging or filling is done in waters of the United States. Land-disturbing activity would be subject to the three standards imposed by G.S. 113A-57 for the control of erosion and sedimentation, and the counties could adopt local sedimentation control programs pursuant to G.S. 113A-60, under which permits for land-disturbing activities could be required. The counties could also regulate development through the adoption of subdivision and zoning ordinances pursuant to Chapter 153A of the General Statutes.

6.3.3.3.2 Legal Aspects of Wet Reclamation and Newly Created Drainage Canals

The following paragraphs outline the laws and regulations that would affect bodies of water, such as isolated lagoons or canals with outlets to rivers or estuaries, created during peat mining.

Excess water from mined areas may in some cases be disposed of in isolated storage ponds dredged from land owned by the mining operator and having no outlet to a sound, river or tributary of a sound or river.

If the isolated ponds are dredged in areas subject to the Corps of Engineers' Section 404 permit jurisdiction, that is, if they are located on "wetlands" within the meaning of Section 404 of the Clean Water Act, then a dredge and fill permit would have to be obtained from the Corps, with an accompanying Environmental Impact Statement. Whether or not the ponds are located on "wetlands," the permit and reclamation provisions of the North Carolina Mining Act of 1971, G.S. 74-46 through G.S. 74-68, are sufficiently broad to cover the dredging of the ponds in conjunction with surface mining, and their construction could be regulated pursuant to those provisions.

The beds and banks of the ponds (whether isolated or having an outlet) would remain in private ownership and would be subject to local ad valorem taxation. However, it is difficult to appraise land lying under water, and it is therefore likely that the ponds would be given a nominal value for tax purposes.

Isolated storage ponds created on "wetlands" within the meaning of Section 404 would remain a part of the wetlands and would continue to be subject to Section 404 dredge and fill permit jurisdiction and Section 402 NPDES jurisdiction after they are filled. Ponds created on land that does not fall within the Section 404 definition of "wetlands" would not be "waters of the United States" under either 33 U.S.C. section 1326(7) or the expansion of that term in 40 C.F.R. section 122.2 because they are artificially created and have no outlets into other waters. As a result, the ponds, once created, would be subject to neither Section 402 nor Section 404 permit jurisdiction under the Clean Water Act. Even though they are not created on wetlands, are artificial, and have no outlets to other waters, the ponds would still come within the broad definition of "waters" in G.S. 143-213(20) and could, therefore, be subject to North Carolina water quality standards and other regulatory controls.

In other cases, excess water from mined areas may be disposed of via canals dredged from land owned by the mining operator opening into a sound or river or tributary of a sound or river (including canals receiving waters from storage ponds with controlled outlets). Canals created in this manner would be subject to Section 404 jurisdiction, and a Corps of Engineers' dredge and fill permit would be required for their creation. Also, a North Carolina dredge and fill permit would be required pursuant to G.S. 113-229.

The beds and banks of the canals would remain in private ownership and would be subject to local ad valorem taxation, with the same difficulty regarding appraisal mentioned above.

The canals, once created (and probably ponds connected by an outlet to such canals), would appear to come within the definition of "waters of the United States" as given in 40 C.F.R. section 122.2, especially in view of the fact that the courts have given the term an expansive definition (see Leslie Salt Co. v. Froehlke, 578 F.2d. 742 (9th Cir. 1978) and U.S. v. Earth Sciences, Inc., 599 F.2d. 368 (10th Cir. 1979)).

Therefore, both Section 402 and Section 404 permit restrictions would apply to the canals.

6.4 Air quality

6.4.1 Approach/Assumptions

The air quality impacts of peat mining and utilization are possible to predict only on a site specific basis. Model predictions require quantitative information on the flux of emitted pollutants from each source, the location of each source, the location of all sensitive receiving areas with respect to the sources, comprehensive meteorological data for the region and an appropriate mathematical dispersion model. In addition, the height above ground at which the pollutants are emitted and any ameliorating conditions must be factored into the model calculations. The cost and complexity of both data gathering and computation limit air quality model development to immediate cases of concern; long range, cumulative air quality impacts are rarely undertaken because of the additional costs and the uncertainty that exists in source location. To date, an air quality impact assessment has only been performed for the PMA methanol production site that roughly corresponds to the methanol production site in Scenario #1, Area 1. Predicted impacts of both fugitive dust emissions during mining and pollutant emissions from methanol conversion are reported in PSD permit applications of PMA to the Division of Environmental Management (PMA, 1981). Because these two source types are assumed to be the same as the scaled up peat mining development of Scenario #2, the PMA document could provide the basis for development of air quality impact models involving the integrated impact of the large-scale peat mining postulated in Scenario #2.

Although it was not possible to build a quantitative integrated model of air quality impacts of peat mining on the scale of Scenario #2 (or even Scenario #1) without specific siting location and scheduling, a review of the data was conducted. Additional information on the following aspects of air quality are included in Appendix 10.8: applicable air quality standards; an expanded discussion of pollutant sources and emissions; critical receptors; models and predictions; and monitoring requirements.

6.4.2 Data

Table 6.4A: Scenario #1, Area 1-- Fugitive dust emissions from peat mining, transport and field pile storage of peat for methanol production

Source	Annual release tons/yr
Harvesting	159
On-site transport	188 (66 tons/yr/round trip vehicle mile)
Field storage piles	34

Note:
Assumes 1900 acres are actively being mined each year with total harvested peat equal to 90.6 x 10^3 tons at 40% moisture per year.
Source:
PMA, 1983a

Table 6.4B: Scenario #1, Area 1-- Criteria pollutant emissions from the methanol plant processing about 1,600 (dry) tons of peat per day

Pollutant	Potential Plant-Wide Air Emissions (tons/yr)	Minimum Emission Levels Requiring PSD Review (tons/yr)	Minimum Emission Requiring BACT Review
Particulates	120.4	100	25
Sulfur Oxides (SO_x)	685.9	100	40
Nitrogen Oxides (NO_x)	560.0	100	40
Carbon Monoxide (C0)	1032.6	100	100
Hydrocarbons (HC)	95.0	100	40
Ozone	98.8		

Source:
PMA, 1981

Table 6.4C: Scenario #1, Area 1-- Non-criteria pollutant emissions from a methanol plant processing about 1,600 (dry) tons of peat per year

Pollutant	Potential Plant-Wide Air Emissions Emissions (tons/yr)	Minimum Emission Levels Requiring PSD Review (tons/yr)
Hydrogen Sulfide (H_2S)	1.0	10
Carbonyl Sulfide (COS)	36.	10
Fluorides (HF)	0.	3
Mercury (Hg)	0.065	0.1
Beryllium (Be)	0.	0.0004

Source:
PMA, 1981

Table 6.4D: Scenario #1, Area 1-- Fugitive particulate analysis, maximum off-property concentrations ($\mu g/M^3$) from peat for methanol project

	Worst Case Mining Location	
	Class II- Annual	Class II- 24 Hour
Activity	Predicted Activity Concentration	Predicted Activity Concentration
Harvesting	4.16	6.65
Athey Loader	0.004	0.009
Storage Piles		
a) Wind Erosion	6.01	8.84
b) Load In/Load Out	Neg.	Neg.
c) Pile Maintenance	Neg.	Neg.
Roadways	5.19	6.52
Plant Contribution	3.05	11.57
Baseline Background	40	40
Total Predicted	58.4	73.58
NC Air Quality Standard	75	150

Table 6.4E: Scenario #1, Area 1-- Fugitive particulate analysis, maximum off-property concentrations ($\mu g/M^3$) from peat for methanol project

	Worst Case Mining Location	
	Class I - Annual	Class I - 24 Hour
Activity	Predicted Activity Concentration	Predicted Activity Concentration
Harvesting	0.03	0.082
Athey Loader	Neg.	Neg.
Storage Piles		
Wind Erosion	0.0092	0.090
Load In/Load Out	Neg.	Neg.
Pile Maintenance	Neg.	Neg.
Roadways	0.012	0.097
Plant Contribution	0.086	2.14
Baseline Background	40	40
Total Predicted	40.13	42.40
NC Air Quality Stand.	75	150

Table 6.4F: Scenario #1, Area 1-- Modeling results: Maximum off-property predicted concentrations* from peat for methanol project

Pollutant	Averaging Period	New Site	Mine Plant	Baseline Background	Total Predicted
Particulates	Annual	3.24	0.12	40	43.36
	24-Hour	12.40	7.34	40	59.7
SO_2	Annual	0.98	-	20	20.98
	24-Hour	6.42	-	20	26.42
	3-Hour	26.41	-	20	46.41
CO	8-Hour	80.12	-	1,000	1,080.12
	1-Hour	230.05	-	1,000	1,230.05
NO_2	Annual	0.67	-	20	20.67
COS	1-Hour	9.67	-	0	9.67

Pollutant	Averaging Period	Class II Increment	N.C. Air Quality Standard
Particulates	Annual	19	
	24-Hour	37	150
SO_2	Annual	20	80
	24-Hour	91	365
	3-Hour	512	1,300
CO	8-Hour	-	10,000
	1-Hour	-	40,000
NO_2	Annual	-	60
COS	1-Hour	-	-

*All minimum concentration and standards expressed in micrograms per cubic meter ($\mu g/M^3$).
Subject to revision pending final permit approval.
Adapted from: PMA, 1981

6.4.3 Conclusions

6.4.3.1 Particulate Emissions During Peat Harvesting and Transport

During the mining and transport of peat, fugitive dust emissions will result from wind erosion of dried surface peat, from peat transport and from peat storage piles. Estimates of these sources have been made by PMA (1983a) and should prove similar for other areas of the region. Table 6.4A lists the estimated source term emissions of fugitive peat dust from these activities. Uncertainties in these emission estimates are very large and there are reasons to suspect that some of them may be biased on the low side (see Appendix 10.8). Direct field measurement of realistic emission rates is urgently needed.

Tilling during peat harvesting and transportation traffic will contribute about equally to predicted fugitive dust emissions, with emissions from field storage piles about five-fold lower.

6.4.3.2 Process Plant Emissions

Methanol production is assumed to be the main point source of air pollutant emissions. Tables 6.4B and 6.4C are based on PMA's analysis (PMA, 1981) and list predicted emissions from the methanol plant in Area 1 of Scenario #1. Subsequent methanol plants could have different emission rates depending on control technologies employed. Nevertheless, the PMA estimates seem reasonable. Because point source emissions such as these are more easily monitored than the dispersed sources of peat harvesting and because control technologies can be more readily evaluated, regulation of emissions to limit air quality impacts can be carried out more effectively and with better assurance that control has been achieved.

6.4.3.3 Fires

Uncontrolled forest and peatland fires are a potential, if unpredictable, source of particulates to the air. Vandenberg and Knoerr (1983) measured particulate deposition in the Lake Phelps vicinity that was approximately ten-fold higher than normal during a period of extensive forest and peatland fires in the same region. If fire management efforts are abandoned during years 8-20 of Scenario #3, an increased probability of uncontrolled fires could degrade air quality, especially in the very short term before flooding of mined areas reduces the fire hazard significantly. Otherwise air quality impacts of Scenario #3 will be similar to those of Scenario #1 during years 1-8 and negligible thereafter.

6.4.3.4 Effects on Air Quality

Worst case estimates of offsite air quality degradation from mining activities for methanol production in Scenario #1, Area 1 are based on PMA's analysis and shown in Tables 6.4D and 6.4E. Maximum off-property predicted concentrations from a single methanol conversion plant serving a 15,000-acre mining tract (i.e. Scenario #1, Area 1) are shown in Table 6.4F.

A single peat-to-methanol plant in Area 1 of Scenario #1 or plants in Areas 3 and 4 of Scenario #2 will not violate North Carolina Air Quality Standards at either Class I or Class II receptor sites under the assumptions used in the PMA model. The distance and direction of Area 2 from the Swanquarter NWR Class I area might preclude such a plant location, but no onsite conversion of peat to methanol is postulated for Area 2 in either Scenario #1 or #2.

An eight-fold increase in methanol production (and SO_2 emissions) as assumed for Scenario #2, Areas 1 and 3, will probably not violate North Carolina Air Quality Standards in Class II areas if the plants are not closely spaced near property boundaries. SO_2 emissions will increase from 686 tons/year to 5488 tons/year (Texasgulf's facility upwind (in terms of the dominant wind vector) at Aurora produces 21,000 tons/year; Weyerhaeuser's facility at Plymouth emits 18,000 tons/year).

Fugitive dust emissions during peat mining, transport and storage are probably a more serious concern than emissions from methanol plants. This is a consequence of the greater particulate emission rates, peat harvesting in all four areas in Scenario #2, and the possibility of emissions immediately adjacent to the mining area boundary.

Estimates of fugitive dust emission impact on air quality are shown in Tables 6.4D and E for a mining operation as considered in Area 1 of Scenario #1. Although no North Carolina State Air Quality Standards are exceeded in these predictions, state standards could be exceeded in Class II areas if the source emission estimates are seriously underestimated (Appendix 10.8) or if harvesting operations are conducted immediately adjacent to property boundaries.

The Swanquarter National Wildlife Refuge (NWR) Class I area is perhaps less likely to suffer transgressions of particulate air quality standards, but more consideration must be given in Scenario #1 to the impact of the nearby Area 2 peat mining region which lies upwind of dominant wind vector during the fall and to Areas 3 and 4 in Scenario #2, which also lie upwind during this season.

6.4.3.5 Amelioration of Impacts through Emission Control

Point sources of pollutant emissions can be more readily controlled than dispersed emissions from in peat mining and transport. Known and effective technological methods to control point source emissions exist, and their effectiveness can be evaluated readily through specific source monitoring. Many pollutant emission reduction technologies have been planned for PMA's methanol plant and accepted as adequate by NRCD and could be augmented as necessary by further emission controls. These methods could be applied to other methanol plants such as those described in Scenario #2.

Controls to limit fugitive dust emissions during peat harvesting and transport are less well tested and more difficult to monitor for effectiveness. Rogers, Golden and Halpern, Inc. (RGH, 1982) suggest four approaches to mitigate fugitive dust emissions during milled peat harvesting operations: 1) planting vegetative windbreaks on the prevailing wind side of the peat drying fields and/or between the fields; 2) harvesting peatlands in narrow strips perpendicular to the prevailing winds; 3) roughening the land surface by making a series of ridges in the fields which trap windblown particles and reduce the wind speed across the fields; and 4) wetting the fields to form a crust on the soil resistant to wind erosion.

A similar set of recommendations has been made by Vandenberg and Knoerr (1983). As yet, neither the effectiveness of such measures nor their direct and indirect costs are known. Such information should be obtained on test plots utilizing local site specific monitoring. Control technologies for dust emissions from roads and storage piles (e.g. wetting and screens) should be evaluated.

6.4.3.6 Effect of Peat Mining in Restricting Future Industrial Growth

As new sources of air pollution are added to a region, the increments of allowable air quality degradation from subsequent sources will be reduced. If allowable increments have been exhausted by prior commitments, additional industrial development would be precluded if such development further degraded air quality.

Vigorous debate has arisen over the potential impact of extensive peat mining and processing in precluding subsequent industrial development. Rogers, Golden, and Halpern, Inc. (RGH, 1982) believe that the Class I Area of Swanquarter NWR would seriously limit industrial development, including peat mining and processing. Representatives of PMA, NRCD and the NC Department of Commerce have argued that site selection and application of control technologies could allow development near the Class I Area. Both contentions are speculative until specific siting and source emission parameters are modeled. To summarize, the state must ensure through the PSD permit process that the allowable increments for pollutants are not exceeded by peat mining, transportation or processing activities. The extensive modeling and planning process that is part of the PSD permit process should, however, enable the state to monitor the expected emissions and to require their control through the permit process.

6.5 Solid waste

6.5.1 Approach/Assumptions

Solid wastes will be generated during peat mining development as a by-product of onsite conversion of peat to secondary products. Mining itself will generate no solid wastes. In the scenarios evaluated, methanol is the only secondary product of onsite conversion. The basis for assessing solid waste impacts is found almost entirely in the Solid Waste Management Plan prepared by PMA (1983).

According to this report, non-hazardous and probably non-hazardous wastes will be generated at the rate of 0.101 tons/ton (dry weight) of peat mined. These wastes include gasifier slag, pelletized gasifier fly dust, clarifier filter cake solids, bottom and fly ash from the boilers, spent catalysts, refuse, dessicants, spent water treatment resins, gypsum from sulfur dioxide recovery, dirt, combined sludge wastage from water treatment and peat solids. Slag, fly dust, ash clarifier solids, gypsum and sludge are the main components. All will be disposed of offsite in sanitary landfills.

Hazardous wastes to be disposed of in secure offsite landfills will be produced at a rate of 0.0019 cubic feet/ton (dry weight) of peat mined. Organic bottom sludges from product storage and bulk plant stock storage have not as yet been characterized more specifically. In addition, potentially hazardous by-product oils, produced at a rate of 0.014 gallons/ton (dry weight) of mined peat, will be disposed of by combustion in the plant boiler.

At these rates of production, wastes will be produced in the amounts shown in Tables 6.5A and B. Because all solid waste is to be directed offsite, outputs from all areas have been pooled.

6.5.2 Data

Table 6.5A: Non-hazardous wastes from peat to methanol conversion

Scenario	Years 1-10	Years 11-20	20-Year Cumulative Total
#1	53,000 tons/yr	53,000 tons/yr	1.06×10^6 tons
	(851,000 ft^3/yr)	(851,000 ft^3/yr)	(17×10^6 ft^3)
#2	135,000 tons/yr	436,000 tons/yr	5.7×10^6 tons
	(2.17×10^6 ft^3/yr)	(7.0×10^6 ft^3/yr)	(92×10^6 ft^3)
#3	53,000 tons/yr	0	0.53×10^6 tons
	(851,000 ft^3/yr)	0	(8.5×10^6 ft^3)

Note:
All figures in ft^3 are based on an assumption of a bulk density of 0.062 tons/ft^3

Table 6.5B: Hazardous wastes from peat to methanol conversion

Scenario	Years 1-10	Years 11-20	20-Year Cumulative Total
#1	1,000 ft^3/yr	1,000 ft^3/yr	20,000 ft^3
#2	2,350 ft^3/yr	8,230 ft^3/yr	108,000 ft^3
#3	1,000 ft^3/yr	0	10,000 ft^3

6.5.3 Conclusions

6.5.3.1 Potential Toxicity of Wastes

Non-hazardous or potentially non-hazardous solid wastes will not present a toxicological threat. They are similar, in part, to coal combustion ashes but will generally contain lower heavy metal concentrations. Leachates of some ashes and slags produced after test gasification of peat did not exceed EPA toxicity criteria for all heavy metals analyzed. However, the finer sized ashes which would be collected in cyclones and electrostatic precipitators were probably not collected in the test gasification. Such particles are known to contain higher concentrations of many elements (including most heavy metals) than slags and coarser ashes, and the elements are generally more readily leachable because they are concentrated on the particle surfaces. Nevertheless, given the relatively low concentrations of most heavy metals in the source peat, leachates from gasification ashes and slags would not be likely to exceed EPA toxicity criteria. However, both the leachability of real process ashes under realistic conditions and the specific charcteristics of proposed landfill sites will need to be evaluated.

Wastewater sludge cannot be well characterized as yet, but includes activated sludge from treatment of organic plant wastewater and alum and lime precipitates from inorganic wastewater. Unless particular toxic compounds from plant operations enter the organic wastewater stream, these wastes are probably correctly categorized as "probably non-hazardous."

Hazardous wastes have not been characterized, but if proper disposal methods are utilized they can probably be handled at secure offsite disposal sites. As pointed out by PMA, the high temperature and oxidizing environment of the gasification stream is unlikely to produce significant amounts of such substances as tars, oils, phenolics and polynuclear aromatic hydrocarbons which are the hazardous by-products of most concern in many synfuels and gasification facilities. No official toxic waste disposal site operates in North Carolina, a limitation to offsite hazardous waste plans.

6.5.3.2 Volume of Solid Waste

The ash content of peat is sufficient that very large volumes of solid wastes will be generated during conversion to methanol. Even if the wastes are not hazardous, disposal offsite of the large volumes produced may prove difficult. Low topographic relief and porous sandy soils limit site availability for sanitary landfills in the Coastal Plain. Given the negative value and large bulk of solid waste material to be disposed of, long distance hauling is unlikely, and local landfills must be used. The 851,000 cubic feet per year of non-hazardous waste predicted in Scenario #1 probably approximates the sanitary landfill utilization currently committed in the Albemarle-Pamlico Peninsula area. The solid waste volumes anticipated in Scenario #2 would exceed the Scenario #1 volumes by a factor of nearly ten during years 11-20.

Washington County has considered expansion of the capacity of its landfill to allow for the accommodation of wastes that could potentially be generated by a methanol plant such as that described in Scenario #1, Area 1 (J. DiSarno, Washington County Manager, personal communication). The landfill is on land leased from a private owner and is operated by an independent contractor pursuant to a county franchise. Thus, the plans and desires of both the landowner and the landfill operator must be taken into account, in addition to the county's needs.

PMA has proposed that much of the non-hazardous waste could be used onsite during reclamation to agriculture and forestry. Ashes and sludges would have some value as soil conditioners, but such use of these materials could affect water quality of runoff and drainage, especially since the relatively low pH of local soils and drainage waters is likely to greatly increase the solubility of many trace elements and metals.

Should the industry fail at year 10 as postulated by Scenario #3, no substantial differences should occur as a result of uncompleted reclamation, disposal, or treatment.

6.6 Fire

6.6.1 Approach/Assumptions

Fire data were obtained from the North Carolina Forest Service office in Fairfield, North Carolina. Data were for Hyde, Tyrrell and Washington Counties for the years 1970 through 1983. This information was used to calculate the frequency of various sized fires and the sources of the fires. Fires from earlier dates were not used. Relatively large scale changes in land use and land cover in these counties have taken place over the past 20 years. The fire data from before this time would not accurately reflect fires controlled by present land use/land cover.

6.6.2 Data

Table 6.6A: Cause of fire (Hyde, Tyrrell and Washington Counties)

	Peat Thickness - in feet									
Cause of Fire	0	1	2	3	4	5	6	7	Total	% of Total
Miscellaneous	1	-	-	-	1	-	-	-	2	2
Railroad	1	-	-	-	-	-	-	-	1	1
Machine use	4	2	-	-	1	2	-	-	10	11
Incendiary	10	-	-	-	-	-	-	-	10	11
Debris burn	27	6	-	3	-	1	-	1	38	44
Smoking	-	1	-	-	-	-	-	-	1	1
Lightning	16	5	-	3	-	2	-	-	26	30
Total =	59	14	0	6	2	5	0	2		
% of Total =	67	16	0	7	2	6	0	2		

Total Number of Fires = 88

Notes:
Peat thickness was obtained by plotting the Forest Service fire location data on the peat thickness map for the three county area.
Data are based on where the fires started, not necessarily on what types of land were ultimately burned.

Table 6.6B: Size of fire (Hyde, Tyrrell and Washington Counties)

Size of Fire (acres)	Peat Thickness - in feet 0	1	2	3	4	5	6	7	Total	% of Total
5,000 +	-	2	-	-	-	-	-	-	2	2
1,000-4,999	3	2	-	-	1	3	-	-	9	10
300-999	3	-	-	-	-	-	-	-	3	3
100-299	9	2	-	1	-	-	-	2	14	16
10-99	37	6	-	4	1	2	-	-	50	58
0.26-9	5	2	-	1	-	-	-	-	8	9
0.25	2	-	-	-	-	-	-	-	2	2
Total =	59	14	0	6	2	5	0	2		
% of Total =	67	16	0	7	2	6	0	2		

Total Numbers of Fires = 88

Note:
Data are based on where the fires started, not necessarily on what types of land were ultimately burned.

6.6.3 Conclusions

1. 67% of the fires started on non-peat soil.
2. 83% of the fires started on either non-peat soil or on peat only one foot thick.
3. 17% of the fires started on peat three feet or greater in thickness.
4. 69% of the fires were less than 100 acres in size.
5. 85% of the fires were less than 300 acres in size.
6. 15% of the fires were larger than 300 acres in size.
7. 70% of the fires were started by people.

8. 30% of the fires were caused by lightning strikes.

9. 44% of the fires were started by debris burns that went out of control.

10. 66% of the fires were caused by some form of clearing, farming, or logging operation.

Fires were concentrated in the non-peat and shallow peat soils because human activity is concentrated there. Most of the peats with greater than 4-foot thicknesses either have no roads into them or have only small canal maintenance roads with limited access. Most of the fires were small because they were either easy to get to, easy to extinguish, and/or they started in areas that were already partially to completely cleared.

Most of the large fires (greater than 1,000 acres) burned into undeveloped areas, thus hindering control, since these areas do not have good fire breaks (roads, large canals, open fields).

If peat mining does occur, no matter which scenario is followed, numerous tracts of land, each up to several thousand acres in size, will be in various stages of site preparation at one time. Two major factors will control each tract's susceptibility to fire: 1) the extent to which the vegetation has been removed and 2) the intensity of field ditching.

If a tract is field ditched, standing surface water will be removed more rapidly and the ground surface will stay dry for longer periods of time. If such a tract has not been cleared of its natural vegetative cover, the associated leaf litter, dead wood and other surficial debris will also dry, providing a quick-burning fuel source. A fire that starts in such an environment will be hard to control. Under such conditions, the frequency and size of fires may increase.

If a tract is subjected to intense drainage operations and is also cleared so that the underlying peat soil is exposed for drying, the fire situation should be different. With the vegetative cover eliminated, the source of a quick-burning fuel will also be gone. As the peat dries and is worked by machinery, it is possible that small fires may occur more frequently. Peat, even when sun-dried, still contains a significant amount of water; hence it is more likely to smolder and remain confined to a small area than to burn with open flames and spread rapidly. The frequency of fires may increase under these conditions, because of the increased human activity, but the size of the fires should stay relatively small.

If large tracts of peat are mined and the underlying mineral soils exposed and planted in either row crop or pine plantation:

1. The number of fires per unit time will increase, since these newly exposed areas will be increasingly utilized by man - the major cause of fire.
2. A greater number of small, more easily controlled fires will occur.
3. The larger, less easily controlled fires will decrease in number, since fewer large blocks of open, undisturbed land will remain.

To the extent that deliberately set fires are a substantial risk, they can be controlled through the open-burning restrictions imposed by G.S. 113-60.23. All three of the study area counties are classified as high-hazard counties, which means that before any fire is set within 500 feet of a woodland, a permit for the fire must be obtained from NRCD.

6.7 Local Economics and Employment

6.7.1 Approach/Assumptions

Available information and data on long- and short-run economic and fiscal and cumulative impacts of the scenarios were collected, relying heavily on data provided by PMA (1983g). (A description of each type of impact and means for analyzing them may be found in Appendix 10.9.) In cases where data were not available, reasonable assumptions were made.

Assumptions made for Scenarios #1 and #3, Area 1 were:

1. The methanol plant will employ 312 persons once it is fully operational.
2. During plant construction (2.5-3 years) 1,452 different workers will be employed.
3. Workers will commute up to 1.25 hours driving time to the plant and mining sites.
4. Approximately 84% of the operation and construction workers will be local (within commuting distance).
5. Approximately 16% of the workers will migrate into Washington and Chowan Counties.
6. Family size for operation workers will average 3.4 people, including 100 children.
7. The number of new residents per 100 construction workers will average 228, including 79 children (many workers do not bring their families with them).

Assumptions made for Scenario #2, Areas 1 and 3:

1. Capacity-employment ratio for the expanded methanol plants is equal to the ratio assumed in Scenario #1.

The status of population, employment, income and the availability of public services in the study area under the no change alternative (present condition) has been documented by PMA (1983g) and is briefly described in section 4.2.

6.7.2 Data

Table 6.7A: Scenario #1, Area 1-- Long-run direct impacts of 525,000 (dry) ton methanol plant

Item	10-County Area
Total employment	312
Local	262
Migrants	50
New residents	170[1]
New school students	50-100
Increase in retail sales	$500,000[2]

Notes:
1. Assumes family size of 3.4 (3.4 x 50 = 170)
2. Assumes retail sales of $2,900 per year per person

Source: PMA, 1983g

Table 6.7B: Scenario #1, Area 1-- Long-run direct plus indirect impacts of 525,000 (dry) ton methanol plant

Item	10-County Area
Mine employment	312
New services employment	172[1]
Total new employment	484
Migrants	77[2]
New residents	262[3]
New students	77[4]

Notes:
1. The employment multiplier (1.55) includes base employment (1.0) and new services employment (0.55). Thus new services employment equals 172 (312 x (1.55 - 1.00)).
2. The PMA study concluded that 16% of the operating labor would not be available locally and would migrate into the area (50/312 = .16). If the same ratio is used here, the estimate of migrants is 77. However, more service industry workers than construction workers would probably be available locally.
3. Assumes family size of 3.4 (3.4 x 77 =262)
4. Assumes 100 students per 100 operations workers

Table 6.7C: Scenario #1, Area 1- Short-run impacts of 525,000 (dry) ton methanol plant

Item	10-County Area Total	10-County Area Peak Employment
Total employment	1,452	1,169
Local	1,054	832
Migrants	398	337
New residents	NA[1]	768[2]
Children	NA[1]	266[3]

Notes:
1. Not available
2. From PMA, 1983g (p. 45)-- 228 residents per 100 workers
3. PMA, 1983g (pp. 45, 46) - 79 children per 100 workers

Source:
PMA, 1983g

Table 6.7D: Scenario #2, Areas 1 & 3-- Long-run direct plus indirect impacts of methanol plants processing 4.1 million (dry) tons of peat

Item	10-County Area
Mine employment	2,449[1]
New services employment	1,347[2]
Total new employment	3,796
Migrants	3,389[3]
New residents	11,523[4]
New students	3,389[5]

Notes:
1. Scenario #2 assumes an expansion of plant capacity to 4.1 million tons, an increase of 7.85. If the capacity-employment ratio remains constant, basic employment in Scenario #2 will be 2,449. ((7.85)312 =2,449).
2. Assumes an employment multiplier of 1.55
3. In Table 6.7B, new employment of 484 leads to immigration of 77, with 407 available locally. Assuming the smaller facility employees are those available locally, the larger facilities must rely solely on migrants. Thus Scenario #2 would lead to immigration of 3,389 workers (3,796 - 407)
4. Assumes family size of 3.4
5. Assumes 100 children per 100 workers.

Table 6.7E: Scenarios #1 and #2, Areas 1, 2 and 4-- Estimated employment for horticultural peat and peat for fuel*

Scenario	Area	Operation	Capacity (dry)	Employment At Years 10	20
#1	1	Horticultural	25,000 tons/yr	6	6
#1	2	Peat for fuel	140,000 tons/yr	33	33
Total Scenario #1				39	39
#2	1	Horticultural	50,000 tons/yr (at 10) 151,000 tons/yr (at 20)	12	36
#2	2	Peat for fuel	368,000 tons/yr (at 10) 1.1 million tons/yr (at 20)	86	258
#2	4	Peat for fuel	432,000 tons/yr (at 10) 1.2 million tons/yr (at 20)	101	281
Total Scenario #2				199	575

Notes:

Estimates of employment in peat for fuel operations are based on PMA estimates of 117 harvesting employees per 500,000 (dry) tons/year. Assumption was made that employees per ton harvested is constant.

Estimates of employment in horticultural operations based on personal communication from Haul Reddick, Peat Fuels, Inc.

* Assumes no construction or processing on site, except bagging of horticultural peat.

6.7.3 Conclusions

6.7.3.1 Peat for Methanol

6.7.3.1.1 Scenario #1, Area 1

6.7.3.1.1.1 Long-run Impacts

6.7.3.1.1.1.1 Economic Impacts

Of the 312 employees expected to be employed at the methanol plant (Area 1, Scenario #1) when it becomes fully operational, approximately 50 will be non-local. Assuming a family size of 3.4, a total of 170 people will thus migrate into the study area. Of these, 50-100 will be children. Also, assuming each generates an average sales volume of $2,900 per year (retail sales volume per capita in Washington and Chowan Counties, 1980), these new residents will stimulate local businesses by $500,000 per year (Table 6.7A). It should be noted that use of $2,900 per person per year (PMA, 1983g) assumes families will contribute, on average, $9,860 per year to retail sales. This may be high considering the current wage levels in the area (see Table 4C) and wage levels expected for migrating workers.

In addition, the migration described above will lead to indirect effects, because the $500,000 that new families will spend will generate demand for new businesses, services and jobs. Assuming an employment multiplier of 1.55, the increase in basic employment of 312 would lead to an increase of 172 jobs in the service sector, giving total direct plus indirect employment of 484 persons in the long run from constructing and operating the methanol plant. Assuming the same proportion of workers would be migrating as was estimated for direct employment (50/312=0.16), the number of migrants needed to fill these service sector positions is estimated to be 77. However, this is likely an overestimate of immigration, because service industries are more apt to increase the labor participation rate in the locality and also to have less stringent skill requirements than does basic employment at the mining facility. The number of new residents employed indirectly resulting from the methanol plant is therefore estimated to be 262. The number of new students is estimated to be 77 (Table 6.7B).

6.7.3.1.1.1.2 Fiscal Impacts

Net revenues to local governments may exceed the costs of services and facilities demanded by new residents. On the other hand, two types of developmental problems may confront local governments in the impacted area. First, long-run fiscal problems may arise in cases where a local government must provide expanded services and facilities but is unable to tax the new plant. This is a spillover problem where new residents locate outside the political boundaries of the local governments that have the power to tax the plant. Second, even if long-run benefits were to exceed costs, front-end or short-run fiscal problems may arise where revenues generated lag cost incidence. For example, local government may need to increase the local school budget immediately upon arrival of new residents, whereas tax revenues generated by those residents or from the plant itself will be lagged several years beyond that time. A short-run cash flow problem will thus arise.

Fiscal impacts will vary by county and city in the 10-county area surrounding the plant. Taxes of several categories will be contributed by the peat mining facilitiy: business property taxes; unemployment taxes; intangible property taxes; inventory taxes; corporate franchise taxes; sales and use taxes; and income taxes on wages and proprietary incomes. However, the distribution of these local and state revenues to individuals and counties will vary greatly. For example, Washington County will receive the bulk of the property taxes, estimated at $900,000 per year (PMA, 1983g). Municipalities and other counties may receive little. Many of the tax categories are paid directly to the state. How and to what extent they are distributed to impacted counties and municipalities will partially determine whether net fiscal impacts are positive or negative.

Demands placed on local governments by new residents will vary in similar fashion. Chowan and Washington Counties will receive most of the influx of new residents. Yet, Washington County will likely receive the largest share of revenue generated by the facility. Chowan County, and particularly the City of Edenton where many new residents will probably reside, will receive much less.

The increased number of students may require an additional school, especially if the influx of students is concentrated in only two areas, Washington and Chowan Counties. Further, even if facilities are adequate, several new teachers will likely need to be hired, and each new pupil will need to be supported. In 1980-81, school expenditures per pupil across the state averaged $1,944.31, including salaries, while in the 10-county impact area, the average expenditure per pupil was $2,103.96 (North Carolina Board of Education, 1982). Based upon these averages, the cost side of the fiscal impact of 50-100 new students is in the order of $105,198- $210,396. Of course, not all of these funds must be generated locally through increased taxes since the source of school funds in North Carolina in 1980-81 averaged 63% state, 19% federal and 18% local. Nevertheless, the local fiscal impact may be a problem because of the lag before receiving the state and federal portions of the money. The distribution of these impacts will also vary between areas.

Finally, new residents immigrating from other areas may be accustomed to a higher level of services than currently exists in the study area so that, in the long run, costs may be incurred to raise the level of services.

Unequal distribution may lead to increased taxes in some areas while at the same time providing surpluses in others. Cities may not fare well fiscally, because they can be expected to bear a large proportion of the demand for new services and facilities, yet receive little property tax revenue because the mine lies outside of their taxing jurisdiction. A more detailed statement concerning school costs and the levels and distribution of other fiscal impacts requires more data than were available for this study. To provide additional assistance to the affected counties, the severance tax discussed in section 4.3.3.3 could be made a state severance tax with some of the funds being returned to the counties where the mining is conducted and to cities and counties in the area as impacted area aid funds, the distribution being made on the basis of demonstrated need.

There is also a concern that the peat mining facility may adversely affect the commercial fishery and recreation/tourism industries. As noted in section 4.2.4, the catch from commercial fishing in Hyde, Tyrrell and Washington Counties was valued at $4.5 million in 1980. In 1982, travel and tourism expenditures were estimated at $11,032,000 in Hyde County, $138,000 in Tyrrell County, and $748,000 in Washington County (M. Dodd, Travel and Tourism Division, North Carolina Department of Commerce, personal communication).

To the extent that peat mining damages the fishery and reduces commercial catch or the attractiveness of the area for recreation and tourism, these economic values will decline. Whether, or the extent to which this may occur, however, is difficult to estimate without further research.

6.7.3.1.1.2 Short-run Impacts

6.7.3.1.1.2.1 Economic Impacts

Short-run impacts of the methanol plant may be great, because the number of construction workers will exceed permanent employment after the plant becomes operational. The number of employees will peak during the middle of the construction period, while tax revenues will peak after the plant becomes operational.

During the peak construction period, the total number of new residents is estimated at 768, including 266 children (Table 6.7C).

6.7.3.1.1.2.2 Fiscal Impacts

Property taxes will be assessed the facility based upon percent of construction completed on January 1 of each year. Yet, the impact of population increase will be more immediate. For example, upon the arrival of a new worker with a family, new school students will be sent to class if it is during the school year. The taxing jurisdiction, however, will not receive the tax revenues until perhaps one to two years later, depending on the rate at which construction proceeds. For those tax or aid categories where the state or federal government returns a portion of revenue collected to the local area or otherwise shares revenue, the lag may be even greater. Often, the distribution of these funds is based upon census population, and any adjustments require waiting for another census. Although school aid is based upon the current year's enrollment, short-run increases in population are often missed by these formulas and produce the revenue lag described.

In the short run, sufficient excess public service capacity probably exists in the area. Thus large, new expenditures for many public services would not appear to be likely. However, operating budgets for some services will increase while capital expenditures may need to be speeded up for others. School budgets will need to be larger even though facilities may be adequate. Improvement and expansion of sewer and solid waste disposal facilities may require added funds in some localities (PMA, 1983g).

As with the long-run impact, the distribution of costs and benefits will vary with some areas experiencing revenue shortfalls and others experiencing surpluses.

6.7.3.1.2 Scenario #2, Areas 1 and 3

6.7.3.1.2.1 Long-run Impacts

6.7.3.1.2.1.1 Economic Impacts

The larger-scale methanol plants in this scenario were assumed to have the same capacity-employment ratio as the plant in Scenario #1. Thus, since Scenario #2 output is 7.85 times (4,120,721 dry tons/525,000 dry tons = 7.85) larger, basic mine employment is also assumed to be 7.85 times larger, or 2,449 persons (Table 6.7D).

Assuming the smaller facility attracts the labor that is

Assuming the smaller facility attracts the labor that is available locally, additional employment for larger facilities must come from immigration. Thus the migrant, new residents and new student impacts will be larger both absolutely and proportionately under Scenario #2 than under Scenario #1. The direct plus indirect employment impact is estimated at 3,796 compared to 484 under Scenario #1. Immigrants increase from 77 to 3,389. Although data are not available, income effects will likely dwarf the impact of Scenario #1 because of the large increase in employment that will provide income to mine workers and service industry personnel.

6.7.3.1.2.1.2 Fiscal Impacts

Although no quantitative information is available regarding the fiscal impacts upon the 10-county area under Scenario #2, potential for the same types of problems exists as for Scenario #1. These fiscal impacts may be expected to be magnified in Scenario #2. For example, the distribution of local governmental costs and revenues will likely be unequal. New residents will probably live outside of areas able to tax the facilities, leading to long-run fiscal surpluses in some counties and/or cities and fiscal deficits in others. The magnitude of each will greatly exceed those of Scenario #1 because of the very large increase in immigration. Since some of the sources of tax revenue are paid to the state, the level of deficit or surplus will depend upon whether and to what extent tax revenues are distributed to impacted counties. Under Scenario #2, the role of state severance taxes could take on increased importance because of the magnitude and possibly more widespread nature of the fiscal impacts.

While an adequate supply of public services and facilites will probably be available to meet the needs of migrants under Scenario #1, it is unlikely that this will be the case under Scenario #2. Table 6.7D shows the large increase in overall population that will be generated, and few cities or counties could provide needed services and facilites for migrants without expanding those capabilities. Overall, there will be a need to invest more public funds to meet these demands. However, the level of demand in a specific county or city will depend upon the location decisions of the new residents and, once again, points out the distributional aspects of the issue. Even with large population increases and increased public investment in services and facilities, local governments receiving a large proportion of the tax revenues may still have surpluses.

On the other hand, the potential for large fiscal deficits is greater under Scenario #2. For example, using school expenditures data presented earlier, if average expenditure per pupil equalled the 1980-81 average in the study area, the increased enrollment of 3,389 students will require increased school expenditures of $7,130,000. Of this, about 20% must be raised locally. New residents will likely concentrate the demand for additional school services in relatively few areas. If those areas are not receiving a large share of the tax revenues generated, deficits may result.

6.7.3.1.2.2 Short-run Impacts

6.7.3.1.2.2.1 Economic Impacts

If methanol production capacity is expanded by a factor of 7 or 8, the short-run impact will depend upon how the expansion is accomplished. If the plants are built or expanded in stages, the short-run impact noted for Scenario #1 may merely continue for a longer period of time. In this case, construction workers will finish one stage before moving on to another. Depending upon the number of stages, this may result in a "short-run impact" of 10-15 years duration if each stage were to take 2.5-3 years, as for Scenario #1. If plant capacity expansion is not staged, the short-run impact may be large, because the number of construction workers is so great. Since no information is available on how larger plants would be constructed, few quantitative comments can be made on the short-run impacts of Scenario #2.

6.7.3.1.2.2.2 Fiscal Impacts

If expansion of plant capacity is staged and does not require more construction workers than did Scenario #1, the short-run fiscal impact will resemble that of Scenario #1, as noted in Table 6.7C. If it is not staged, the potential short-run fiscal impact will be greater, because the influx of new residents will be greater. In this case, public service and facility capacity will likely be exceeded, and short-run impacts will be greater, just as was the case in the long-run.

The distribution of costs and revenues among alternative local governments will again be important.

6.7.3.1.2.2.3 Cumulative Impacts

The expansion of peat mining activity from the level indicated in Scenario #1 to that of Scenario #2 will attract other related industries and enterprises that will magnify the impacts of the mining activity itself. In addition, the potential for related industries locating in the area will be greater than in Scenario #1, because of the greater methanol output and the larger number of people immigrating into the area. In this case, employment and income multipliers will be greater, as will fiscal impacts.

6.7.3.1.3 Scenario #3, Area 1

The socioeconomic impact of industry failure upon cities and counties will depend upon the level of development that had occurred (i. e., the level of employment and income that had been generated) and the extent of excess capacity built by local government (schools, waste disposal, etc.). Unemployment will be created proportional to the increase in employment generated by operation of the peat mining facility. Income will be lost by unemployed mine workers (direct effect) and by workers and businesses serving the basic mining industry (indirect effect). Fixed facilities constructed will be unused unless other economic activities replace demand lost with the mining facility. This includes housing, businesses and public facilities. Social impacts will be similar to effects in other areas in recent years, where workers are unemployed and family conditions suffer.

The extent of the fiscal impact will depend upon the extent to which local government has expanded the services it provides. Excess capacity and high costs of government may result if service construction programs have been accelerated. Other services, such as the number of school teachers, can be reduced, but this will lead to higher unemployment and related costs. Tax revenues will fall, but costs of operating local government will also decrease. Since many services of local government cannot be proportionally adjusted downward once provided (e. g., a wastewater treatment plant or school), and since many are funded by long-term debt, the reduction in tax revenues will be greater than the reduction in costs of local government. If this does occur, the costs of operating local government will rise unless offset in some other manner. Property taxes will rise accordingly.

6.7.3.2 Peat for Fuel and Horticultural Peat

The fiscal impacts noted earlier in section 6.7.3.1 will be magnified to the extent new migrants are employed for harvesting and processing horticultural peat and peat for fuel. The earlier discussion of these impacts is applicable here. Insufficient information is available to estimate short-run and long-run economic impacts of horticultural peat and peat for fuel operations, as was done for the peat for methanol facility. However, direct employment is estimated as shown in Table 6.7E for Scenario #1 (Areas 1, 2) and Scenario #2 (Areas 1, 2, 4) at years 10 and 20. These numbers are equivalent to long-run impacts because of the time frame they cover.

For Scenario #1, Areas 1 and 2, total base employment is estimated at 39 for each of the years. Assuming an employment multiplier of 1.55 as before, new services employment may be expected to increase by 22 (0.55 x 39) for a total direct plus indirect employment impact of 61 (22 + 39). If 16% migrate into the area, 10 new migrant workers will arrive and, assuming a family size of 3.4, will increase population in the study area by 34. The number of new students will increase by about ten. At $2,900 average retail sales per person, retail sales will increase by about $98,000 per year.

Using the same procedures for Scenario #2, Areas 1, 2 and 4, new services employment at year 10 is estimated to be 110 (199 x 0.55) for a total direct plus indirect employment increase of 309. If 16% of the workers (50) migrate into the area and family size is 3.4, population will increase by 170, and the number of students will increase by about 50. Retail sales will increase by $493,000. At year 20 the increases are: direct employment, 575; direct plus new services employment, 892; migration of workers, 143; population, 487; students, 143; and retail sales, $1,400,000.

7. EVALUATION PROCESS

7.1 Estuarine Impacts

7.1.1 Statement of the Problem

7.1.1.1 Introductory Section

Large-scale peat mining and related land conversion activities (reclamation) as described in the upper boundary scenario (#2) (see section 5.2.3) have the potential to substantially alter primary nursery areas if mining takes place adjacent to estuaries. While this project has considered the cumulative impacts of three alternative peat mining development scenarios, the effects of other forms of land conversion of peatlands (e.g., to agriculture and forestry) on estuarine systems are similar in many respects. For this reason, the following discussion is focussed on the impacts on estuarine systems peripheral to the Albemarle-Pamlico Peninsula of land conversion activities in general. Changes in salinity regimes, nutrient loading, suspended solids, sedimentation, trace element, pesticide and coliform bacteria levels, and interactions among these factors are believed to be the most significant potential estuarine impacts from land conversions. The processes by which these impacts are effected and the interrelationships among them are poorly understood. Decision makers are therefore required to act without an adequate data base and with considerable risk.

7.1.1.2 Land Conversions

Drainage pattern alteration on the Albemarle-Pamlico Peninsula for agricultural and silvicultural purposes is discussed in section 4.1.2.5. According to McMullan (1984), approximately 12.4% of the peninsula's land area had been cleared prior to the 1940s. By 1963, 1974 and 1981, 18.5%, 26.2% and 29.6%, respectively, of the land area had been cleared. Large-scale peat mining and related reclamation activities would obviously continue and accelerate this process of land conversion on the peninsula (see section 6.3).

7.1.1.3 Salinity

Although overall salinities in Pamlico Sound would probably not be significantly affected by runoff from large-scale land conversion on the Albemarle-Pamlico Peninsula since it contributes only about 6-8% of the total freshwater inflow, a more dramatic effect may occur in the smaller streams and bays linking the peninsula and Pamlico Sound. Many of these small tidal creeks have been identified by the North Carolina Division of Marine Fisheries as "primary nursery areas", the most productive and sensitive of the state's nursery grounds for economically important species of fish and shellfish. These primary nursery areas are characterized by soft mud sediments, proximity to regularly or irregularly flooded marshes, and salinities ranging from 5 to 15 parts per thousand (ppt) (Pate and Jones, 1981).

Studies conducted by Pate and Jones (1981) of primary nursery areas receiving heavy, moderate and no upland drainage through man-made canals indicated that salinities at the unaltered sites were more stable during periods of high runoff than those recorded at two sites receiving drainage waters through ditches. Their research raised the possibility that production of brown shrimp and other commercially important fish may be adversely affected by freshwater "pulsing" via drainage canals into primary nursery areas during and following storm events.

7.1.1.4 Nutrient Loading

All North Carolina estuaries can support enhanced algal growth in response to accelerated nutrient (both nitrogen and phosphorus) loading (Stanley and Hobbie, 1977; Kuenzler et al., 1979, 1982; Paerl, 1982, 1983; Paerl et al., 1984). The worst manifestations of growth enhancement are blooms of blue-green algae which are restricted to freshwater or oligohaline (less than 2 ppt salinity) habitats. Nutrient loadings projected for the upper boundary scenario (#2) (see section 6.2.1.2) appear to be sufficient to support blooms in these upper estuarine waters. If so, salinity would limit the areal extent of blue-green algal bloom conditions. The offshore extent of such conditions is currently unknown.

Virtually nothing is known about marine bloom "analog" taxa which could develop in higher salinity (in excess of 2-5 ppt) estuarine waters (Paerl et al., 1984).

Recent research has illustrated the negative impacts of blue-green algal biomass on herbivorous consumers (zooplankton). Assimilation and trophic transfer of such biomass are greatly reduced in comparison to non-blue-green algal food sources (Fulton and Paerl, in prep). In the event of documented bloom potentials and events, food chain alterations may therefore be expected in receiving estuarine waters. This research is of long-term relevance with respect to economic (fisheries) impacts in the Albemarle-Pamlico Sound systems.

7.1.1.5 Physical Stratification Impacts on Water Quality

Current research efforts into the causes and proliferation of nuisance blue-green algal blooms in the Chowan and Neuse River systems have strongly linked vertical stratification characteristics to bloom potentials. The chief reason for this direct relationship is the habitat preferences of nuisance taxa.

All nuisance blue-green algal taxa, including Microcystis, Anabaena and Aphanizomenon, have the ability to become buoyant during stagnant periods when the water column is vertically stratified (either due to thermal or salinity stratification). Buoyancy is a response which, from an ecological standpoint, greatly favors the growth of blue-green taxa over more desirable (non-buoyant) algal groups, such as diatoms, green algae and flagellates. During stratified periods blue-green algae can float to the surface, thereby capturing optimal amounts of sunlight for photosynthetic production and net growth, while shading underlying algae.

It is not presently known whether such stratification potentials exist, and, if so, what their duration and seasonality are.

7.1.1.6 Suspended Solids and Sedimentation

Because the peninsula has very little relief, erosion is not a significant problem. Development of peatlands causes a slight increase in sediment loads in drainage waters, particularly during land clearing, buried wood removal and field shaping. Thus, disturbance caused by peat mining may be expected to increase sediment loads in drainage canals unless settling ponds or other measures to remove suspended sediment from drainage waters are utilized. Once initial development activities are completed, erosion and turbidity during normal agricultural production are not likely to cause water quality problems (Skaggs et al., 1980).

The normal hydrology of North Carolina estuaries causes them to function as sediment and nutrient traps. Increasing salinity down the estuary neutralizes the electrical charges on colloidal organic and clay particles, resulting in flocculation and sedimentation. The sediments are usually soft, organic-rich muds which constitute a huge sink for oxygen in the overlying water. Most of the sediment is mineral matter, silts and clays from the Piedmont as well as from local areas of the Coastal Plain. The remainder is organic matter, some relatively resistant material of terrestrial origin and some more labile material originating from phytoplankton (Matson et al., 1983). Microbial activity in the sediments and chemical transformations release ammonium and phosphate to the bottom water, some of which moves upstream, thus recycling the nutrients to the phytoplankton and resulting in high levels of productivity (Stanley and Hobbie, 1977; Kuenzler et al., 1979; Kuenzler et al., 1982; Paerl, 1982, 1983). High levels of summertime production which occur in the middle reaches of Pamlico River (Kuenzler et al., 1979) have not been considered noxious. Similar or higher productivities in fresher parts of the Chowan and Neuse Rivers, however, have included blooms of blue-green algae which are not only noxious but may also adversely affect fisheries (Stanley and Hobbie, 1977; Kuenzler et al., 1982; Paerl, 1982, 1983; Copeland et al., 1983).

As a result of soil disturbance and diversions and alterations of surface and subsurface runoff during land conversion activities, changes in the humic and fulvic acid content of receiving waters may occur. Humic and fulvic acids impact both the transparency and chemical characteristics (pH, metal availability) of receiving waters (Paerl, 1982, 1983). Both characteristics are known to affect algal production potentials. Transparency alterations can regulate photosynthesis, and hence primary production, in subsurface depths of the water column. Metals such as iron, manganese, copper and zinc are required for growth among both desirable and nuisance algal species. These metals are strongly chelated or chemically bound by humic and (particularly) fulvic acids. Differential metal binding therefore affects metal availability, which in turn can affect algal growth potentials.

7.1.1.7 Trace Metals

Concern regarding the possible effects of peat mining on the release of trace metals was triggered by reports by ESE (1983), a consultant for PMA, of elevated mercury concentrations (above state and federal standards) in canals draining naturally vegetated peatlands. More recent monitoring by the state Department of Natural Resources and Community Development has generally failed to find mercury concentrations above the EPA recommended criteria (0.2 parts per billion (ppb)). (The current state standard for mercury is 0.05 ppb, however, a standard revision to 0.02 ppb is presently under consideration.) The bulk of available mercury data, however, reflects pre-mining rather than during- or post-mining conditions. Studies from Finland (Simola and Lodenius, 1982) and Minnesota (Clausen et al., 1980) have reported increased mercury fluxes into receiving systems, apparently as a consequence of peatland drainage.

Other metals which have higher standards than mercury may be deleterious to nursery areas. For example, lead concentrations in excess of the state standard (which is 30 ppb vs. 0.05 ppb for mercury) have been reported by PMA (1983f). In terms of toxicity to fish larvae, there is very little difference between waterborne lead and mercury. The difference in standards reflects concern for the health of humans, not fish, and is due to the greater ability of mercury to biomagnify in food chains.

Skaggs et al. (1980) suggested that peatland disturbances associated with agriculture will significantly increase fluxes into receiving systems of three metals which the researchers measured: copper, manganese and zinc (cadmium concentrations were below detection limits). It is likely that other elements, particularly those that exist largely as divalent cations, will demonstrate similar trends. The cumulative impacts of excessive amounts of these trace metals, as well as interactions among trace metals and other substances, deserve further study.

7.1.1.8 Pesticides

Potentially of greater concern than trace metals is the increased influx of pesticides likely to occur with extensive conversion of undeveloped lands on the peninsula to row crop agriculture.

Skaggs et al. (1980) reported concentrations of the herbicide Alachlor within the 95% confidence interval of the LD_{50} for bluegill (Johnson and Finley, 1980) in field ditches draining peatlands. No data are available for other pesticides, including numerous insecticides used in the region that are far more toxic to aquatic organisms than Alachlor is. Data were not collected from main drainage canals, and concentrations in water reaching the estuaries would be expected to be considerably lower than concentrations in field ditches. However, the potential for pesticides to reach and impact estuarine nursery areas merits consideration.

7.1.1.9 Coliform Bacteria

Research by Skaggs et al. (1980) indicated that the average number of fecal and total coliform bacteria in drainage waters from developed shallow and deep organic soils was considerably higher than from similar undeveloped areas. These coliforms came from lands under cultivation as well as in pasture, although bacterial concentrations from the latter were higher. Increases in bacteria may be due to a generally lower acidity in drainage waters from developed lands because of liming.

One potential problem with development of organic soils adjacent to estuaries for pastures or row crop agriculture is the introduction of fecal organisms via drainage waters into shellfishing waters. While non-fecal coliform bacteria are not harmful, they are used as indicators of human pathogens.

7.1.2 Data and Information Available

Solution to the problem requires an understanding of estuarine physical, chemical and biological processes, how they impact upon estuarine organisms and how these processes are affected by upland activities. Such "understandings" are usually portrayed through a model.

7.1.2.1 General Approaches to System Representation

The past decade has seen the development of a great range of models of three general types: 1) empirical, regression models, 2) loading vs. trophic state models and 3) numerical models.

Empirical, regression models have been developed for temperate lakes which show a strong relationship between a limiting nutrient (usually phosphorus) and algal chlorophyll levels (e.g., Dillon and Rigler, 1974). Such models have the appeal of simplicity and, sometimes, high correlations with field conditions, but have not performed reliably in dystrophic fresh waters or estuaries. Lauria and O'Melia (1980) suggested that in the Pamlico Estuary phosphorus is limiting in winter and nitrogen in summer. They developed two steady-state, one dimensional (seasonal) models to predict water quality in the estuary under different nutrient loadings. Thus factors controlling trophic status may vary temporally as well as spatially and a single empirical, regression model may not be adequate to predict conditions over a complete annual cycle.

Extension of empirical, regression models produced models relating trophic state to phosphorus loading rate, water depth, water detention time and other variables (Vollenweider, 1968, 1975; Dillon, 1975; Larsen and Mercier, 1975). These models have proved useful for many lakes, especially since the ultimate stress (nutrient loading from land runoff) is one of the independent variables. Furthermore, trophic state is preferable to chlorophyll-a content because it may be defined in other terms which are important for a particular water body. This approach has apparently been used by Lee and Jones (1979). They expressed strong support for the Organization for Economic Cooperation and Development (OECD) approach (Seyb and Randolph, 1977; Rast and Lee, 1978), extending the use of the nutrient load/eutrophication relationships to estuarine waters. Lee and Jones (1979) inserted data from the Potomac River Estuary into a Vollenweider-type plot, a step which had not been done before. They argued that the low cost and generality of this approach make it useful for estuaries as well as lakes.

A large number of numerical, simulation or dynamic models describing aquatic systems has been developed within the past fifteen years (Chen and Orlob, 1972; Kelly, 1972; O'Connor et al., 1973; Johnson, 1974; Johanson et al., 1976; Harleman et al., 1977; Vernberg et al., 1977, 1978; Kelly and Spofford, 1977; Kremer and Nixon, 1978; Roesch et al., 1979; Ambrose et al., 1980; Neale et al., 1981; Burns et al., 1981; Clark and Feigner, 1982; and many others). Most of these models include hydrodynamic, water quality and biological components. They encompass a range of model types including one, two and three dimensions, laterally and depth-averaged, and a variety of water quality parameters, including salinity, temperature, phosphorus, nitrogen, DO, BOD, turbidity and toxics.

7.1.2.2 Prior Modeling Work in North Carolina

Several water quality models have been developed for North Carolina waters. As mentioned in section 7.1.2.1, Lauria and O'Melia (1980) developed a model for predicting water quality in the Pamlico Estuary under different nutrient loadings. Amein and Galler (1979) generated a water quality management model for the lower Chowan River, which consisted of a flow dynamics module and a water quality module. The flow dynamics module was based on the finite difference representation of the equations for the conservation of mass and momentum for water flow in estuaries. Variables included water stage, wind direction and wind speed. The water quality module included DO, BOD, nitrite plus nitrate nitrogen, ammonia nitrogen, organic nitrogen and algal biomass. The module utilized computations on photosynthesis and nutrient uptake by algae. It was a time-dependent or unsteady flow model which also predicted nutrient concentrations and algal abundance. However, neither the Lauria and O'Melia nor the Amein and Galler model has been used by the state Division of Environmental Management (DEM) to date because of the large volume of data (currently unavailable) needed to fit all the parameters.

In response to recurrence of nuisance surface blooms of blue-green algae in the lower Chowan River, DEM has adopted a management strategy based on a phosphorus loading/chlorophyll-a model. The model was developed by Chapra and Tarapchak (1976, cited by DEM, 1982) based on the phosphorus concentration/loading relationship and phosphorus/chlorophyll-a relationship developed by Dillon and Rigler (1974, cited by DEM, 1982). This simple model takes into account the effect of variations in annual discharge on average total phosphorus concentrations, but cannot predict the effects of seasonal variability in flushing rates and/or short-term fluctuations in phosphorus concentrations on phytoplankton biomass (chlorophyll-a). Neither does the model account for the many physical factors that cause the massive surface blooms and peak chlorophyll-a levels. It is hoped that the model will provide a good indication of how the river responds to increases or reductions in phosphorus loading over several years (DEM, 1982).

A simplified approach to predicting the "suitability" of an area to support a given wildlife species has been developed by the U. S. Fish and Wildlife Service (1980). Their Habitat Evaluation Procedures (HEP) relate environmental conditions to life requisites for indicator organisms, and may be employed in space, time or both. Many of the details contained in more sophisticated approaches are by-passed or consolidated in HEP (e.g., bottom type may serve as proxy for food), and the models are difficult to validate (they allege to measure "quality" or "suitability", but efficient validators of quality and suitability are evasive). Even with its limitations, the strengths and practicability of the HEP approach have been recognized and it is becoming widely applied. For example, the HEP approach has been used in terrestrial (Lancia et al., 1982; Noffsinger et al., 1983; Lancia et al., 1984) and estuarine environments in North Carolina (Adams et al., 1982; Adams and Overton, 1983).

A finite element numerical hydrodynamic model was developed by Wei (1983) at NCSU, and has been used in several projects in North Carolina. The model has been linked to simple habitat suitability models to predict impacts of salinity introductions into Currituck Sound (Adams and Overton, 1983) and channel modifications in the White Oak Estuary (Adams et al., 1982). Adaptations of this model and other existing models should provide the foundation of the modeling efforts discussed in section 7.1.3.

7.1.2.3 Other Relevant Studies

Kremer and Nixon (1978) developed a mechanistic numerical model of a temperate estuary (Narragansett Bay, Rhode Island). Their model used known forcing functions to predict temperature, solar radiation, tidal circulation, exchange with an adjacent sound and river flow, and empirically derived growth relationships to predict phytoplankton-zooplankton-nutrient dynamics in the estuary.

Kremer and Nixon (1978) used temperature as the variable controlling the absolute maximum growth rate of phytoplankton (Eppley, 1972). Nutrient limitation of phytoplankton growth was calculated from the concentrations of phosphate, silicate and inorganic nitrogen relative to the half-saturation coefficient for these nutrients. The third factor affecting growth was light. Annual changes in intensity and day length, cloudiness and water transparency were incorporated. Computations linked the phytoplankton growth model to the physical forcing functions in the estuary. These factors and their relationships to phytoplankton productivity are not fundamentally different from those of North Carolina estuaries, and a similar model would likely be satisfactory.

The zooplankton community of North Carolina estuaries may be simulated by the zooplankton model of Kremer and Nixon (1978). This model includes such controlling variables as temperature, food availability, filtering rate, reproduction, respiration, egestion, predation and cannibalism in order to compute the productivities of several kinds of planktonic animals.

The roles of the benthos in the Narragansett Bay model were two: 1) phytoplankton grazing (filtration by bivalves) and 2) nutrient regeneration. Few data were available on the dynamics of estuarine benthic communities and, as a result, a program to measure feeding, respiration and nutrient regeneration rates in situ was initiated. For purposes of the model, a daily clearing rate for the bivalve population was determined from pumping rate and duration projections as a function of temperature. Nutrient regeneration with temperature was based on in situ flux measurements made in the bay (Kremer and Nixon, 1978).

The effects of adult fish and higher trophic levels were not included in the model of Narragansett Bay because the authors believed it unlikely that this predation exerts significant influences on the planktonic system and because omitting this level simplified model development.

The U.S. Army Corps of Engineers (Edinger and Buchak, 1981; Buchak and Edinger, 1982) has developed a two-dimensional numerical estuarine model laterally averaged in space. The model currently includes circulation, salinity and temperature. Water quality constituents such as dissolved oxygen and nitrogen will eventually be included. Water quality models will then be linked to a vertically averaged model. The Corps plans to develop a three-dimensional estuarine model within the next several years. The objective of the entire study is to develop methods for evaluating the impact of changes in circulation on the water quality of estuarine systems.

7.1.2.4 Data Sources

The type of data currently available and needed in developing a simulation model is reviewed below. Although extensive data exist, the data base is currently insufficient to address many of the problems discussed in section 7.1.1. For example, the current question on the distribution of the vertical salinity profile during freshwater pulsing and the possibility of stratification cannot be answered with biweekly data at one location in the absence of runoff data or pre-event conditions. The system is too complex to be described by spatial or temporal averages.

7.1.2.4.1 Hydrodynamic/Water Quality Data

Baseline data needed for the development of a hydrodynamic model include a bathymetric survey, current measurements, tidal elevation changes and wind speed and direction. Because of the time dependent nature of the model, values of all the parameters are required at some initial time (to be used as initial conditions). At designated boundaries, time varying values of the parameters are required (to be used as boundary conditions). For initial model development, the data could be compiled from existing sources (i.e., from the bulk of literature that describes previous estuarine studies in North Carolina). However, for model refinement and verification, additional field data would be required. The specific form of the data needed can best be described as the model is developed and simulation requirements are defined.

Some of the water quality data needed may be available from DEM, which conducts two water quality monitoring programs. In the Ambient Water Monitoring Program 300 sites statewide (approximately 25 in the study area) are monitored monthly for temperature, dissolved oxygen, pH, alkalinity, specific conductance, biological oxygen demand (BOD5) and fecal coliform and quarterly for turbidity, chemical oxygen demand (COD), arsenic, mercury and general metals. The Basic Water Monitoring Program samples monthly for temperature, DO, pH, alkalinity, conductivity, secchi disc, salinity, turbidity, BOD5, COD, fecal coliform, total nitrogen, NO_2 and NO_3, total Kjeldahl nitrogen, PO_4 and total phosphorus and quarterly for cadmium, total chromium, cobalt, copper, iron, lead, magnesium, mercury, zinc and arsenic at 37 sites, including one each in Albemarle Sound and Pamlico Sound (DEM, undated).

7.1.2.4.2 Biological Data

Sampling for phytoplankton biomass and species composition in the study area is conducted by the Biological Monitoring Group of the Water Quality Section of DEM. Sampling stations are located in the Chowan, Alligator, Pungo and Pamlico Rivers and Albemarle Sound. Sampling schedules vary, but nutrient data and chlorophyll-a measurements are taken whenever phytoplankton is sampled.

Very little is known about zooplankton in estuaries. However, sampling for zooplankton is currently underway in the Neuse River Estuary.

The state Division of Marine Fisheries (DMF) has been conducting a monthly survey of fish (March through November) in nursery areas since 1974. Data on temperature, salinity (surface and bottom) and juvenile catch data are taken. Depth, sediment type, % carbon, nitrogen, and organic matter in the sediment and sediment size have also been recorded for each station. These primary nursery area stations are not located in the same places as DEM's sampling stations, however, the two agencies are considering joint sampling efforts for the future.

As part of an effort to evaluate and update its programs for coastal water quality DEM has been compiling scientific information on water quality impacts on key species in estuarine nursery areas. In addition to reviewing published reports, DEM is also conducting an analysis of five years of catch data collected in primary nursery areas by DMF. The analysis of the DMF catch data focuses on brown, white and pink shrimp; blue crab; croaker; menhaden; southern flounder and spot. The relationship between juvenile catch and bottom salinity is the analysis of primary interest, however, several other factors including water temperature and some bottom sediment characteristics are also being examined. The literature review and data analysis may enable DEM to specify a salinity threshold above and below which a particular species is not likely to occur. The information will be integrated to develop possible water quality criteria for primary nursery areas and water quality regulations may be proposed.

7.1.3 Recommended Approach

7.1.3.1 General Approach

A substantial body of research, conducted over the past 10 to 15 years, has improved our understanding of the behavior of estuarine systems and the land-based activities that affect these systems, yet a sufficient informational framework for decision making remains elusive. It can be concluded, however, that 1) estuarine systems and their relationships to land influences are extremely complex, 2) site specific research must be undertaken to determine which factors are most important in a particular environment, 3) data and information on components of the system must fit into an overall system framework, and 4) the requisite effort will require large expenditures of resources over a long period of time (at least a decade). At least three approaches to the problem are possible.

The first assumes that we now have an understanding of the system sufficient to support development of a comprehensive, large-scale simulation. Proponents of this approach argue that some parts of the system may be poorly understood, but that sensitivity analyses can be used to identify the most important sources of uncertainty, which can then be addressed by future research.

The second approach presupposes that sufficient information is available to begin developing parts of the overall system, but that data and information gaps will preclude completion. Under this approach, model-building would proceed on parts of the system until stopped by data and information limitations. Research efforts would then be initiated to correct these deficiencies, while the modeling effort shifted to another sector. The "model" would thus serve to identify data gaps as well as to integrate available data and information into the whole.

The third approach is based on the belief that existing knowledge is so deficient that research efforts must be limited to studies of small areas of the system. Under this approach individual research projects would continue to be supported, but no effort to integrate results into a larger concept would be attempted until a later date.

The research team favors the second alternative. It permits individual research efforts to continue, funded from a variety of sources, yet encourages efforts toward beginning to understand the larger system. If the state should pursue this alternative, the team recommends limiting the initial geographic extent and the number of water quality parameters and biological components of the modeling effort and maximizing the amount of field calibration and validation. As experience and expertise increase, the effort may be expanded in scope and complexity.

Regardless of the approach adopted, the data and information required can be organized into three subsystems: 1) the land use-hydrologic subsystem that generates inputs into the estuary (from the Upland Water Management simulation, section 7.3); 2) an estuarine physical-chemical system; and 3) an estuarine biological system.

7.1.3.2 Physical-Chemical Aspects

The hydrodynamic component derives from the three dimensional equations of motion which describe the conservation of fluid mass and momentum. Variables in the equations are the three components of velocity, pressure and water elevation. These equations fully depict the hydrodynamics of the system. Forcing functions are provided by specifying boundary and initial conditions. Factors such as winds, tides, currents bottom topography and bottom materials are included in initial and/or boundary conditions. Therefore, the basis for the model is somewhat independent of the simulation criteria. However, the mathematical model and the numerical technique chosen to solve these equations will depend in part on the form of the input provided by the Upland Water Management model (section 7.3) and the output required by the biological component (section 7.1.3.3). These interfaces must be compatible. For example, if spatial resolution in the vertical dimension is necessary, a depth-averaged form of the equations above and a boundary integral method of solution would be inappropriate.

The water quality component should be developed for the specific parameters under consideration (i.e., salinity, nitrogen, phosphorus, suspended solids). For example, the balance equations could be written in three dimensions for salinity distribution and solved for each time step. The water quality component would interface with the hydrodynamic component by using the solutions from the hydrodynamic component as input to the water quality component. The temporal and spatial resolution provided will be determined in part from the requirements of the biological model and these requirements, in turn, might influence the development of both the hydrodynamic model and the numerical solution technique chosen.

Parameters to be considered include:

1. Physical characteristics of receiving waters
   a. Surface flow rates, volumes, vertical and stratification characteristics of receiving estuaries.
   b. Turbidity, light penetration characteristics.
   c. Yearly temperature fluctuations of entire water column.

2. Chemical characteristics of receiving waters
   a. Seasonal and spatial (vertical) distribution of salinity, major nutrients (including NH_4, NO_3, PO_4), pH in riverine and receiving estuarine habitats.
   b. Total nitrogen (Kjeldahl) and total phosphorus determinations on seasonal and spatial bases.
   c. Alkalinity (dissolved inorganic carbon) on a seasonal basis in rivers and oligohaline estuarine habitats.

7.1.3.3 Biological Aspects of an Estuarine Model

The estuarine biological model component relates simulated physical-chemical conditions to phytoplankton, zooplankton, benthos and higher consumers. It may be based on environmental limiting factors affecting indicator organisms or nutrient cycling, food chains and energy flow, or more complicated relationships, and may consider short-term or long-term conditions. The estuarine biological model is the least understood component of the overall modeling efffort and will require a considerable investment before meaningful results can be expected.

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Parameters to be considered include:

1. Biological characteristics of receiving waters
   a. Particulate chlorophyll-a concentrations on a seasonal and spatial (vertical distribution) basis in riverine and estuarine habitats.
   b. Algal community composition (as major groups - Cyanophyceae, Chlorophyceae, Dinophyceae, etc.) on a seasonal and spatial basis.
   c. Zooplankton community composition and biomass (again as major groups of cladocerans, copepods, insect larvae, rotifers, microzooplankton and icthyoplankton) on a seasonal basis, using integrated (over depth) water column samples in major rivers and estuarine environments.

2. Biophysical processes
   a. Seasonal growth limitation effects of nutrients on phytoplankton.

b. Seasonal primary productivity at selected water column locations, as indicative of actual growth potentials of phytoplankton under natural (ambient) conditions.
c. Relationships between salinity, water flow, water column stratification and the potential for algal growth (blooms) (seasonal).
d. Relationships between salinity, water flow and dissolved oxygen in the water column (seasonal).
e. Nutrient exchange between the sediments and water column on a seasonal basis. Relationship of nutrient inputs and outputs to overall nutrient availability for phytoplankton growth.
f. Current food chains utilizing particulate matter generated in and entering the estuary, including major rates of food utilization, preferred food types and preferred herbivorous grazers sustaining commercially and recreationally important finfish and shellfish species. Current rates of food transfer (fluxes) along identifiable links in the estuarine food chain. (The choices of desirable phytoplankton food sources and herbivore grazers depends on the desired finfish or shellfish resources.)
g. Interactions of estuarine salinity gradients with qualitative and quantitative aspects of primary and secondary productivity.
h. Hydrological and nutrient loading "mass balance" budgets to predict the impacts of altered freshwater nutrient loading on quantitative and qualitative characteristics of estuarine primary productivitiy. In other words, the relationship of nutrient loading to both the amounts and types of algal production desired.

7.1.3.4 Application

An estuarine model could be used as a means of understanding the system and identifying significant data gaps. In addition, such a model would allow decision makers to assess the impacts of existing and proposed coastal land use on the state's estuarine resources.

7.1.3.4.1 Regulatory Implications

An estuarine model could also be used as the basis for setting effluent limitations to meet water quality standards for primary nursery areas, should such standards be established by the Environmental Management Commission.

7.1.3.4.2 Legal Aspects of the Control of Freshwater Drainage into Primary Nursery Areas

The assumption has been made here that a major portion of the fresh water drained from the mining activities will enter "waters of the United States" (rivers, sounds, estuaries) via either man-made or improved canals and ditches.

The discharge of fresh water into the brackish waters of the primary nursery areas probably cannot be controlled through the NPDES permit process in the same direct way that BOD or TSS, for example, are controlled. This is because fresh water is not included in the definition of "pollutant" in 33 U.S.C. section 1362(6) (Clean Water Act), and the primary basis for control under an NPDES permit is to limit the discharge of "pollutants," as defined. Nor do any of the effluent limitations promulgated by EPA for various categories of point sources include fresh water among the standards.

In order for the NPDES permit system to be used to control fresh water discharges, the Environmental Management Commission must create a classification for the nursery areas with accompanying water quality standards that specify a required range of salinity. The statutory basis for classifying waters of the state and applying standards to the classifications is G.S. 143-214.1. Of special interest for present purposes are G.S. 143-214.1(d) (3), which requires the Environmental Management Commission to consider the extent to which the waters are being used for "fish and wildlife and their culture," and G.S. 143-214.1(d)(4), which requires the Commission, in adopting new classifications or standards, to consider the use and value of the waters for the "propagation of fish and wildlife." Statutory definitions that support a classification of the nursery areas are G.S. 143-213(20), which includes swamps, sounds, tidal estuaries and bays within the definition of "waters", and G.S. 143-213(19), which defines "water pollution" broadly as being the "man-made or man-induced alteration of the chemical, physical, biological, or radiological integrity of the waters of the State, including, but specifically not limited to, alterations resulting from the concentration or increase of natural pollutants caused by man-related activities."

Once the classification and standards have been adopted, the standard must be submitted to EPA for approval pursuant to 33 U.S.C. section 1313(c). Once EPA has approved the standards, then any NPDES permit issued that would affect the classified waters -- whether issued by EPA or the state -- must, pursuant to 40 C.F.R. section 122.44(d)(1), contain conditions that are designed to protect those standards.

A second possible approach, independent of the NPDES permit, but still relying on a classification and standards, would be to require a state permit for the discharge pursuant to G.S. 143-215.1(a)(6). In this regard, the definition of "waste" in G.S. 143-213(18)b appears to be comprehensive enough to include fresh water drained from mining activities; the water in this case is a "waste substance ... resulting from ... the development of any natural resource."

A third possible approach, which could be used in conjunction with the adoption of a classification and standards or without the adoption of a classification, would be to require a permit for the discharge of fresh water into the nursery areas pursuant to G.S. 143-215.1(a)(10). This provision was adopted to enable the state to assume authority over the discharge of pollutants into aquaculture projects pursuant to 33 U.S.C. section 1328(c). The language of G.S. 143-215.1(a)(10), however, appears to be broader than necessary to implement the federal statutory requirement. The state statute is phrased in terms of a broad prohibition against the discharge of pollutants into one of the described areas, whereas the federal statute gives authority to EPA to allow the discharge of specific pollutants into aquaculture projects under certain conditions. The breadth of language in the state statute may allow it to be used in this situation, but before it may be used the state must show that the primary nursery areas that are of concern are "defined managed area(s) of the State's waters for the maintenance or production of harvestable freshwater, estuarine, or marine plants or animals."

A fourth possibility, once a classification and standards have been adopted, would be to condition the mining permit on the taking of actions necessary to protect the salinity or other water quality standards for the nursery areas. This may be done pursuant to G.S. 74-51(3), which provides that the permit may be denied if the activity would violate surface water quality standards, and G.S. 74-49(13), which requires the reclamation plan to include a plan for compliance with state water pollution laws.

A fifth possibility would be a special order issued pursuant to G.S. 113-230 to control activities in coastal wetlands for the protection of marine fisheries. The use of this approach would require the Secretary of Natural Resources and Community Developmet to make use of the expanded definition of "coastal wetlands" allowed by G.S. 113-230(a) to include not only "marshes," as defined in G.S. 113-229(n)(3), but also "such contiguous land as the Secretary reasonably deems necessary to affect by any such order in carrying out the purposes of this section."

7.2 Wildlife

7.2.1 Statement of the Problem

Natural resource development on the Albemarle-Pamlico Peninsula inevitably involves conversion of one habitat-land use type to another and concommitant faunal changes. In the scenarios evaluated, the most significant conversions were from pocosin vegetation to mining to agriculture, and the most significant adverse wildlife impacts were upon black bear and bobcat. The bear, in particular, is intolerant of human disturbance and requires large areas of suitable habitat. The coastal plain population is under considerable stress. Under the most extreme conditions evaluated (Scenario #2, Area 1) (see section 6.1.4.3.2), bear habitat quality in the impacted area would be reduced by 40%; under the most favorable conditions (Scenario #3, Area 2) (see section 6.1.4.3.3), habitat quality would be reduced by 28%. Bobcat habitat quality, under the same circumstances, would be reduced by 30% and 19%.

The validity of these conclusions rests on two unproven assumptions. First, habitat quality indices used in modeling impacts were derived from a consensus of wildlife biologists familiar with the area and were intended to measure the "goodness" of each habitat-land use type from the standpoint of each species considered. No field data were used in developing these models, nor was there any attempt to validate the results. Secondly, indices applied to post-project conditions assumed certain degrees of effectiveness for buffer strips and other mitigation measures, none of which has been field tested.

Thus, the results represent state-of-the-art efforts within the time and funding constraints imposed by the project, but their reliability is yet to be tested.

7.2.2 Data and Information Available

7.2.2.1 Habitat Quality Modeling

The procedure used in predicting wildlife habitat impacts was developed by the U.S. Fish and Wildlife Service, and is termed Habitat Evaluation Procedures (HEP) (U.S. Fish and Wildlife Service, 1980). It consists of 1) inventorying the land use-habitat types on the study area, 2) selecting evaluation species, 3) determining a Habitat Suitability Index (HSI) for each habitat type for each species, 4) estimating the rate of change from one type to another, 5) accruing habitat quality units for each species over the project period, and 6) evaluating results in terms of impacts on individual evaluation species and on "wildlife" as a whole as represented by the sum of indicator species (or guilds). Models for numerous species have been developed by the Fish and Wildlife Service.

HEP are usually used in the form described above, emphasizing temporal changes at the expense of spatial considerations. Another approach, developed at N. C. State University (Adams et al., 1982b), applies HEP principles in a spatial context, but is unable to efficiently consider changes in continuous time (although before- and after-project conditions can be evaluated). No means for considering both spatial and temporal aspects of habitat conversion currenty exist, although both are important in evaluating impacts on wildlife.

In a temporal context, HEP have been used in North Carolina to evaluate effects of the Falls Reservoir (Hair, 1978) and Prulean Farms' Section 404 permit application (Noffsinger et al., 1983). In a spatial context, they have been employed to assess proposals to introduce salt water into Currituck Sound (Adams and Overton, 1983) and to assess efforts to improve circulation in the White Oak River Estuary (Adams et al., 1982a). In these examples, no effort was made to validate results beyond findings of "reasonableness" and acceptance by peers.

The concept of validation is itself hazy, and more efforts toward validation by field data are needed. Although HSIs are alleged to measure "suitability" or "quality", these terms are difficult to define and more difficult to measure. Lancia et al. (1982) attempted to validate a bobcat model (with reasonably good results) and various songbird models (with mixed results). Other researchers (Whelan et al., 1979) had similar experiences. Common, specialized species with small home ranges are more easily modeled; rare, generalized, and far ranging species are more difficult. Frequency and intensity of use appear to be better validation criteria than population density. Limiting factors other than habitat quality (e.g. predation, social interactions, accessibility, demographic and behavioral factors) frequently confound field validation attempts.

Despite these weaknesses, the HEP approach appears to possess the potential for evolving into a useful and credible tool for assessing land conversion impacts. At the present time, it has no competition. Efforts must therefore be expended toward improving this system as it may be applied to land conversions on the Albemarle-Pamlico Peninsula.

7.2.2.2 Mitigation

During- and post-project HSIs used in this study considered mitigation efforts currently included in mining permits and those proposed in draft form (as of March, 1984) within the North Carolina Wildlife Resources Commission. The latter describes a Regional Peat Mining Reclamation Plan containing "interconnecting wildlife habitat corridors" linking state and federal land and proposed Natural Areas, "buffer strips" along natural water bodies, and "buffer strips and filter strips" as part of individual mine site reclamation plans. While specifications (length, width, separation, vegetation, management) are suggested in the draft and must be part of any implementing documents, no data exist by which one could assess animals' reactions to these mitigative efforts or evaluate trade-offs between dedication of land to wildlife mitigation and other more economically rewarding uses.

A second approach to mitigation emphasizes modifications of customary land management practices to lessen adverse impacts upon wildlife without changing basic land use patterns. Somewhat analogous to Best Management Practices (BMPs) developed in response to Section 208 of PL 92-500, these measures could include minimum ditch and canal bank disturbance (reducing erosion and sedimentation and destruction of muskrat food plants), minimal channel maintenance (lessening impact upon fish and other aquatic biota), encouraging woody vegetation along canal banks (reducing erosion, shading out aquatic weeds), minimum tillage (leaving unharvested grain exposed over the winter, reducing erosion), and many others. The efficacy of this approach, in contrast to mitigaton based more on land dedication, is untested.

In reality, a combination of habitat preservation, BMPs and monitoring efforts may be the most likely approach.

7.2.3 Recommended Approach

7.2.3.1 Habitat Quality Modeling

Two efforts are required. The first would validate HSIs for selected species (particularly black bear and bobcat) using field data from the study area. The second would link spatial and temporal aspects of the modeling concept in a form usable for "real-time" decision making.

While the procedure for field validation and improvement of models is relatively straightforward, many more validations need to be completed to document and/or improve the accuracy of the HSIs. Wide ranging and rare species have been particularly evasive, and require extensive study areas and considerable time and expense. In this instance, the validation project should:

1. Consider black bear and bobcat.

2. Develop species-habitat models incorporating spatial considerations, based on literature and consensus of area biologists.

3. Predict habitat quality for each species over a large study area (several thousand acres) on the peninsula.

4. Correlate habitat quality, as determined by the models, with animal presence, use intensity, use frequency, or other validator.

5. Revise original models to improve correlations.

6. Test revised models in another, similar, area.

Techniques and procedures are reasonably well known and proven; fiscal, personnel, and materiel requirements should be readily estimated; and definitive results should be attained.

The second element, linkage of spatial and temporal considerations, is much less certain. Conceptually, one should be able to iterate a spatial model through time, apply it to a computer-generated habitat map of the study area, inject types and locations of management decisions, and perform all operations on an easily accessible micro-computer. Such a system would permit a land manager to evaluate alternative land use decisions prior to execution, assessing their wildlife impact before commitments were made on the ground.

In approaching this element, the following steps would be taken:

1. Enter a land inventory into a computer and obtain graphic output on the monitor.

2. Load a program containing species-habitat models for species of interest.

3. Indicate a decision (time,space) to modify part of the study area.

4. Obtain a computer-generated map of the revised land use distribution.

5. Obtain an analysis of the impact of the decision upon species of interest.

6. Advance time by any desired increment, and repeat the procedure.

7. Continue the process through a reasonable time span, and obtain an analysis of accrued impacts.

8. Repeat the process until the implications of the decisions are known and the results satisfactory.

Development of this procedure will require a considerable, but difficult to quantify, investment. One is never sure of the cost of developing a computer program until it has been developed. Nevertheless, the evolution of decision oriented models for wildlife habitat impact assessment is moving in this direction, and the process will not be complete until spatial and temporal considerations can be evaluated in real time.

7.2.3.2 Mitigation

Two approaches may be employed. The first would use observations of existing situations, similar but not necessarily identical to recommended mitigation, as indications of results to be expected. The second would employ a designed array of potential mitigation measures.

Distributed throughout the peninsula are numerous examples of potential mitigation measures, created over time through random and/or fortuitous land use decisions. Buffer strips of various dimensions and character do exist along some fields; relict stands of natural vegetation, of varying area, have survived agricultural development here and there; linkages and corridors among escape cover and refuges can be found; and examples of diverse agricultural practices impacting upon wildlife species occur. Observations of wildlife use (hence habitat "goodness") under these varying conditions could provide guidance, with no development cost in time or money, for those stipulating mitigation as part of permit conditions. Under this approach, the following steps would be taken:

1. Determine the array (dimensions, age, vegetation, management practices, etc.) of potential mitigation measures of interest.
2. Select a preliminary set of examples through analysis of historic aerial photos.
3. Confirm suitability through ground surveys.
4. Determine abundance and use intensity by species of interest in each site.
5. Relate use intensity to site characteristics; optimize for species of concern.
6. Use results as bases for specifying permit conditions.

7. Monitor results and adjust specifications accordingly.

This approach could be implemented immediately, before permits are issued, at no development cost. Results could be available within a short time, probably before significant mining development occurs, and in time to amend outstanding permits with minimal trauma. There would be no opportunity to design a well-balanced, precise experiment, however. Some conditions would be under-represented or missing, while others would be over-represented. Replications and experimental intervals between examples would thus be unequal and erratic, and statistical analyses may be more complicated and less powerful than in the following alternative.

Conditions attached to mining permits provide a vehicle for: 1) designing an experiment in alternative mitigation and implementing it as part of the mining-reclamation operation, or 2) entering into a cooperative agreement with a permittee under which a long-term mitigation program could be conducted and evaluated. Under this approach, the following steps would be taken:

1. Design a balanced array of mitigation alternatives, including land dedication and management practices, that would provide a spectrum of conditions significant to the species concerned (particularly bear and bobcat).

2. Include specifications for the array as part of permit conditions or under a cooperative agreement with a permittee.

3. Implement the mitigation plan.

4. Evaluate resulting conditions in terms of animal use or other validator.

5. Determine the optimum mitigation plan, based on results from above.

6. Amend existing permits, condition future permits, accordingly.

This approach has the advantage of better experimental design and simpler and more powerful statistical analysis. It incurs significant development costs, in both time and money, however.

7.2.3.3 Application

The recommendations outlined above will provide a firm factual basis for addressing the most critical wildlife habitat problems associated with peat mining or other land use conversions on the peninsula. Results can be implemented through permit conditions (mining; Section 10, Section 404; CAMA; etc.), BMPs and general educational programs.

7.3 Upland Water Management

7.3.1 Hydrology of Existing Natural Conditions

7.3.1.1 Statement of the Problem

Large sections of the areas potentially available for peat mining on the Albemarle-Pamlico Peninsula are covered in natural pocosin vegetation (see Appendix 10.1). The rate and variability of the runoff from these areas are not well known, either from ditched (1.5 mi. blocks) or unditched areas. A specific problem is the lack of detailed understanding of the magnitude and behavior of bank storage flow, the release of water from the banks immediately adjacent to a canal or ditch following an infiltration event. Potential runoff from agricultural land can be estimated, but a better understanding of the existing conditions is needed for accurate assessment of the environmental impacts of mining or otherwise altering natural pocosin areas.

7.3.1.2 Data and Information Available

Pocosin areas are characterized by a thick porous mat of roots and decaying vegetation overlying the peat. This mat restricts evaporation from the peat and is also responsible for rapid interflow of rainfall. Because of the large pores in the mat, it is rarely saturated. During rainfall it absorbs water rapidly. This water then infiltrates the underlying peat at a much slower rate or, if the peat is saturated to the surface, flows through the porous mat, fairly rapidly, to the nearest available outlet. Badr (1978) determined hydraulic conductivities of this layer at about 26 ft/hr or higher. Runoff data exist from a previous study of a ditched pocosin area (1/2 mi^2 block) (Skaggs et al., 1980). Water table depths at the center of the same block are also available for about three years.

Another distinctive feature of the pocosin areas is the magnitude of the effect of the bank storage. Any water that may be released into a ditch or canal from the adjacent banks will tend to be a fairly significant percentage of the total water lost from a field by subsurface flow following a rainfall event. This is because of the very low hydraulic conductivity (approximately 0.008 in/hr) of the peat which, in general, keeps the subsurface drainage very low but also allows the bank storage zone to "fill up" more than would occur in a mineral soil. This is also complicated by flow through the porous mat which tends to "extend the bank storage effects" farther back from the ditches than would normally be expected.

7.3.1.3 Recommended Approach

Various modeling techniques need to be investigated in relation to this problem, which previously has been looked at on a per unit area basis. Water balances at a point have been performed by Purisinsit (1982) using the DRAINMOD computer model. Solutions to the water balance and water flow equations need to be found over an area. A two-dimensional, finite element solution technique would achieve this. The hydrology of the root mat should be examined closely. A technique for routing flow through the root mat and over the ground surface would be desirable. Also, improved, simpler methods of routing flows through the canal systems to the outlets need to be developed for determining the impact of field scale changes on runoff reaching estuaries.

In addition to the modeling approach, a number of field experiments are required to improve data for the models as well as to gather information to improve our knowledge and understanding of the hydrologic processes in these areas: 1) the characteristics of the root mat need to be analyzed; 2) improved descriptions of the root mat's depth, conductivity and effect on infiltration to the peat layer underneath are required (infiltrometer experiments are suggested, with the rings extending to the peat layer beneath the root mat); 3) average rooting depths of the vegetation should be determined as valuable inputs to the modeling effort; and 4) additional measurements from large unditched natural areas are also needed.

7.3.2 Nutrient Transformation in Canal and River Networks

7.3.2.1 Statement of the Problem

Good data exist on the nutrient and sediment losses from a mined or agricultural area at the field edge (Skaggs et al., 1980). However, it is necessary to know what transformations take place within canal or river networks draining into estuaries. This would enable more accurate predictions to be made of the effects of field level operations on the ultimate receiving waters.

7.3.2.2 Data and Information Available

Some data have been collected by Gregory et al. (1984) and PMA (1982c, 1983f).

7.3.2.3 Recommended Approach

A monitoring network along several existing canals being fed from a number of different land use types would be required. Continuous sampling for nutrients, sediment and possibly metals, herbicides and pesticides following rainfall events of varying magnitudes as well as under base flow conditions, would help answer many of these questions. This question is being investigated to a limited extent by Gilliam et al. (1983).

Data obtained in these studies would provide input to the hydrodynamic/water quality component of the estuarine model discussed in section 7.1.

7.3.3 Improved Field Data and Modeling for Actively Mined Areas

7.3.3.1 Statement of the Problem

Development of better field runoff measuring techniques is needed. Existing flow measuring techniques (weirs with stage level recorders) are prone to problems (e.g., clogging, submergence). The need for improved field data for both model input and model testing is particularly great for the actively mined and pocosin areas. The present modeling work for these habitat-land use types is based on many assumptions which should be verified or updated.

7.3.3.2 Data and Information Available

Flows from areas under active mining appear to be much higher than flows from unmined fields. The primary reasons are: 1) increased compaction from heavy machinery; 2) improved surface drainage from land forming and extra ditches; 3) the removal of vegetation, reducing transpiration; and 4) the harvesting of the dry surface layer which otherwise functions as a "storage reservoir" for subsequent rainfall. Current modeling predicts that during mining the average annual flow from a field will increase by about 35% over the pre-mining condition. All of this increase is in the surface runoff component which is predicted to increase by up to 130% over the pre-mining surface runoff from disturbed (pasture) lands and by a higher percentage from natural pocosin areas.

Field data collected by ESE (1983) and Gregory et al. (1984) illustrate increases in total volume, flow duration and flow peaks from the sites opened for mining over the pre-mining sites. However, data from all of the largest storms were lost due to weir submergence or clogging with debris or silt.

7.3.3.3 Recommended Approach

One or more actively mined field sites should be monitored to record all of the water leaving them. One possible method would require the use of some form of unrestricted outlet from the site with a control structure through which all water leaving the site would be forced to pass. Another approach would be to isolate and pump all of the water leaving the site. An effective series of debris and sediment traps would be required upstream of the control structure in the canal or field ditch to prevent clogging and erroneous results.

A detailed soil property analysis of the surface layer of an actively mined site should be made. Infiltration properties of the peat vary with wetting and drying in a more exaggerated manner than is the case for mineral soils. The hydrologic properties of the layer of peat exposed and allowed to dry change during the drying process. Knowledge of the nature and rate of these changes would greatly assist in modeling efforts. The modeling allows "average" conditions to be approximated by simulating a situation over many years of climatological data. Thus by comparing the long-term average runoff before, during and after mining, realistic conclusions may be drawn regarding the expected hydrologic effects of peat mining. Single event analysis is more difficult to set up accurately enough to get reliable results.

Data from these efforts would provide input to the estuarine model (see section 7.1).

7.3.4 Wet Reclamation and Perpetual Pumping

7.3.4.1 Statement of the Problem

Proposed reclamation plans include or are likely to include lakes for flow regulation or areas of "wet reclamation". Many of these areas will require pumping. Models should be developed that are capable of handling areas with outlets controlled by weir structures or pumps.

7.3.4.2 Data and Information Available

ESE (1983), using the SWMM III model, incorporated the storage lake proposed by PMA into the system modeled. Both available lake storage and the buffering effect of the lake were considered. The outlet from the lake was controlled by a weir with a maximum discharge and a minimum depth below which there was zero flow. The flood routing model used by Gregory et al. (1984) has the capability of modeling a controlled outlet situation. This feature, however, has not been tested on the extremely small slopes existing on the peatlands.

7.3.4.3 Recommended Approach

Modifications to existing models may be used to analyze the hydrologic effects of pumped outlets on flow rates from mined or reclaimed areas. The modifications would be required in the flood routing sections of the models. Inputs to these sections would come from estimated water losses from fields either on a per unit area basis or on an areawide basis as, for example, from a two-dimensional, finite element model of the soil and water system.

For wet reclamation or lake areas, a short time period water balance could be used. If inputs to the lake, outlet relationships as a function of lake depth, and the lake area are known, a water balance can be determined on, for example, an hourly basis. This would give the expected outflow from the lake area over time. The variation in flow rates, as well as total flows on a monthly or annual basis, could be determined.

Again, data from these studies would provide input to an estuarine model (see section 7.1), enhancing evaluation of the effectiveness of storage lakes in reducing negative estuarine impacts of land drainage.

7.3.5 Wetland Filter Areas for Overland Treatment of Runoff

7.3.5.1 Statement of the Problem

The use of wetland buffer areas has been proposed as a method for the treatment of agricultural drainage water (Governor's Coastal Water Management Task Force, 1982). The effectiveness of lagoons and wetland filter areas for removing nutrients and sediments and reducing fresh water pulsing from reclaimed agricultural areas must be determined.

7.3.5.2 Data and Information Available

Work in other states (Florida, Minnesota, Maryland and Massachusetts), primarily on municipal wastewater treatment, is not very applicable to North Carolina conditions. Previous research projects in North Carolina (Kuenzler et al., 1980; Brinson et al., 1981) on nutrient removal and cycling in swamp ecosystems were conducted on different soil systems and under different conditions than exist on the Albemarle-Pamlico Peninsula. A number of farms in eastern North Carolina are using forested wetlands as treatment areas for agricultural drainage water. This technique is highly recommended, especially for areas close to the estuarine receiving waters. Wetland filters are also an option for mined areas reclaimed to agriculture. At this time, no established criteria exist for determining the size of buffer areas, although the Governor's Coastal Water Management Task Force (1982) has recommended broad guidelines for the use of filter areas for pumped drainage pending the development of precise design criteria. Further research is needed on the actual effectiveness of wetland buffers for treatment of overland runoff. Gilliam et al. (1983) are currently investigating the hydrologic and nutrient removal characteristics of two wetland buffer areas. These two areas are on soil types and in locations considered typical of peatlands reclaimed to agriculture. Preliminary results from this project are exected in July, 1984.

7.3.5.3 Recommended Approach

The number of locations investigated in the Gilliam et al. (1983) project should be increased to include a greater variety of soil and vegetation types. This project should be expanded to examine vegetative changes in buffer areas over time and the effectiveness of buffer areas for the treatment of drainage water. The relationships between different management practices in drainage areas (e.g., crop rotations, fertilizer applications) and the required buffer area specifications should be investigated. Filtration capabilities of wetland buffers for other compounds including pesticides and metals (if used) should also be studied.

Ongoing and proposed studies outlined in this section would provide input to an estuarine model (see section 7.1), ultimately enabling resource managers to evaluate the effects on estuaries of the use of wetland buffer areas for filtration of drainage waters.

7.3.6 Effects of Peat Mining on Groundwater and Saltwater Intrusion

7.3.6.1 Statement of the Problem

The effects of drainage systems, peat harvesting and surface water pumping on the location of the fresh/saltwater interface in very low lying areas and areas adjacent to estuaries is not well understood. Specifically this issue should be investigated in areas where mining could extend close to or below sea level.

If groundwater pumping is to be required for construction dewatering or for plant process water, the effect on the aquifers should be investigated more thoroughly. Particular concerns include effects of groundwater withdrawals on local wells and the potential for saltwater intrusion into aquifers.

7.3.6.2 Data and Information Available

Theoretically, for every foot of fresh water above sea level, 40 feet of fresh water is stored below sea level (if steady state conditions are attained). Therefore, any action that results in lowering the fresh water table by even a small amount could be amplified by a factor as high as 40 in its effect on the groundwater storage. However, the fresh/saltwater interface is not distinct on the Albemarle-Pamlico Peninsula. The estuarine water varies in salinity up to almost fresh in the river mouths (Alligator, Pungo). In addition, the different hydraulic conductivities of the various geologic layers tend to obscure the exact location of the interface.

The peninsula is not considered an area of significant groundwater recharge, based on work by Foutz (1983). He determined the recharge rate to be less than 0.04 in/year. Foutz did not, however, consider the lowering of the piezometric head in the deep aquifers by operations such as phosphate mining in the region. While such operations would clearly increase the recharge to the groundwater, the magnitude of the effects would probably be small. This could be investigated in the modeling approach suggested below.

Recent groundwater studies by Heath (1975), LBG (1983) and Foutz (1983), as well as ongoing studies by the U.S. Geological Survey, have been inconsistent in their estimates of aquifer depths and properties, specifically, aquifer transmissivities. A number of studies have been performed, including those mentioned above, on which improved modeling investigations of the effects of peat mining operations on the fresh/saltwater interface could be based (Henry, 1964; Collins, 1971; Shamir and Dugan, 1971).

7.3.6.3 Recommended Approach

The development of a comprehensive three dimensional, finite element model is proposed. All available data from pumping and drill logs should be accumulated for the Albemarle-Pamlico area. Extra drilling should be planned to fill in any gaps in the data to adequately describe the geologic profile as well as to resolve any contradictions in the available data. The model should be flexible enough to address both small areas of development (less than 10,000 acres) and the peninsula as a whole.

The U.S. Geological Survey (U.S.G.S.), in addition to conducting a monitoring program, is in the process of calibrating a groundwater model to known well data on a regional scale. There appears to be a good potential for the U.S.G.S. work to answer many of the regional groundwater questions raised by this project.

7.4 Hurricane Flooding

7.4.1 Statement of the Problem/Data and Information Available

The low relief terrain along the North Carolina coast and surrounding the state's major estuaries is subject to periodic inundation by high water associated with onshore wind tides. Onshore winds associated with hurricanes can drive massive quantities of saline waters into the estuaries, up coastal rivers and over adjacent low-lying lands. Similar flooding can occur if floodwaters feeding into the estuaries from upstream drainage systems are met by onshore winds and are prevented from draining into the open ocean. The following statements regarding the effects of such flooding are based on Wilder, Robison and Lindskov's 1978 study of the water resources of northeastern North Carolina (Wilder et al., 1978), with only minimal modification to include peat mining as a possible land use.

The possibility of flooding is an important consideration in planning land use on the Albemarle-Pamlico Peninsula. As the low-lying areas are cleared and drained for agriculture, or if peat is removed, further lowering the ground surface, the likelihood of major economic losses caused by wind-driven floodwaters increases. Freshwater flooding would cause immediate damage to crops and to other land uses, and delays in drainage would impede recovery. Wind tides associated with hurricanes or other major onshore storms are likely to transport salt water that will destroy growing crops and may create an undesirable soil environment for long periods of time after floodwaters have receded. Under natural conditions the deleterious effects of inundation by saline waters are minimized because the high fresh water table impedes the percolation of these floodwaters into the soil zone. Man-made drainage systems, however, can directly or indirectly effectively lower this water table. As a result, during storms floodwaters may infiltrate the enlarged unsaturated zone (where evaporation and ion-exchange processes can concentrate the salts in the soil zones) in larger portions of the land.

In addition, removing peat from large tracts of land will create extensive depressional landscapes. These depressional features may hold floodwaters for long periods of time, depending on pump capacity. Concentrations of salts in soils can be removed by leaching with fresh water and surficial treatment with lime and gypsum, but the loss of the use of the land for agriculture for one or more years is possible.

Prediction of the frequency with which a given location is likely to be flooded with water from the estuaries or sounds is inexact because of the almost infinite number of possible combinations of wind direction and velocity, shoreline configuration and fetch, as well as the effects of vegetation and man-made structures in impeding free advancement of a wave. Some idea of the severity of the problem can be obtained from Figure 7.4A, on which are delineated approximate boundaries of wind-tide floods likely to be equalled or exceeded 50% and 1% of the years. By "exceeded" is meant that inundation of an area at least as great as that shown is likely every other year on the average at the 50% probability, and once every hundred years on the average at 1% probability. These are average frequencies over long periods of time, and no specific interval between two consecutive events is implied. A flood with a 1% chance of occurring in any year will cover a large part of the study area. However, all of the area with an equal chance of being flooded at a given frequency will seldom, if ever, be flooded by the same storm. For example, strong southerly winds may cause inundation along the northern shorelines of a body of water, while actually lowering water levels along the southern shorelines.

It is important also to qualify the accuracy of Figure 7.4A. The boundary outlining the area inundated by a flood with a 1% chance of exceedance was transferred directly from flood-prone area maps available from the U.S. Geological Survey. The lines on the maps are general and are not as detailed as those appearing on the large-scale flood-prone maps. More accurate data are available from the Geological Survey and from floodplain information studies completed by the U. S. Army Corps of Engineers. The flood with a 50% chance of exceedance was sketched on the large-scale flood-prone area maps using a flood stage from 2.5 to 3.5 feet below the flood outlined as having a 1% chance of exceedance. These maps are based only on wave heights and land elevation, with no consideration of the damping effect of dense vegetation or man-made structures, and thus the maps tend to overestimate the extent of inundation.

The National Flood Insurance Administration is currently working on a series of detailed elevation maps for a large portion of the North Carolina Coastal Plain. These maps will include flood boundary lines for numerous intensities of storms.

7.4.2 Recommended Approach

To determine the extent of this problem, the following steps should be taken:

1. Develop a new series of detailed large scale flood-prone area maps, based on new land elevations, as determined by the amount of peat that potentially could be removed from peat deposits in the region.
2. If the hypothetical removal of peat from a given deposit increases the susceptibility to flooding, the underlying sediments should be examined to determine their potential for floodwater infiltration.

3. If certain areas are found to be underlain with highly porous and permeable sediments that would allow rapid infiltration, this factor would have to be taken into consideration, either in the decision to allow mining in the area, or in the proposed post-mining reclamation plans.

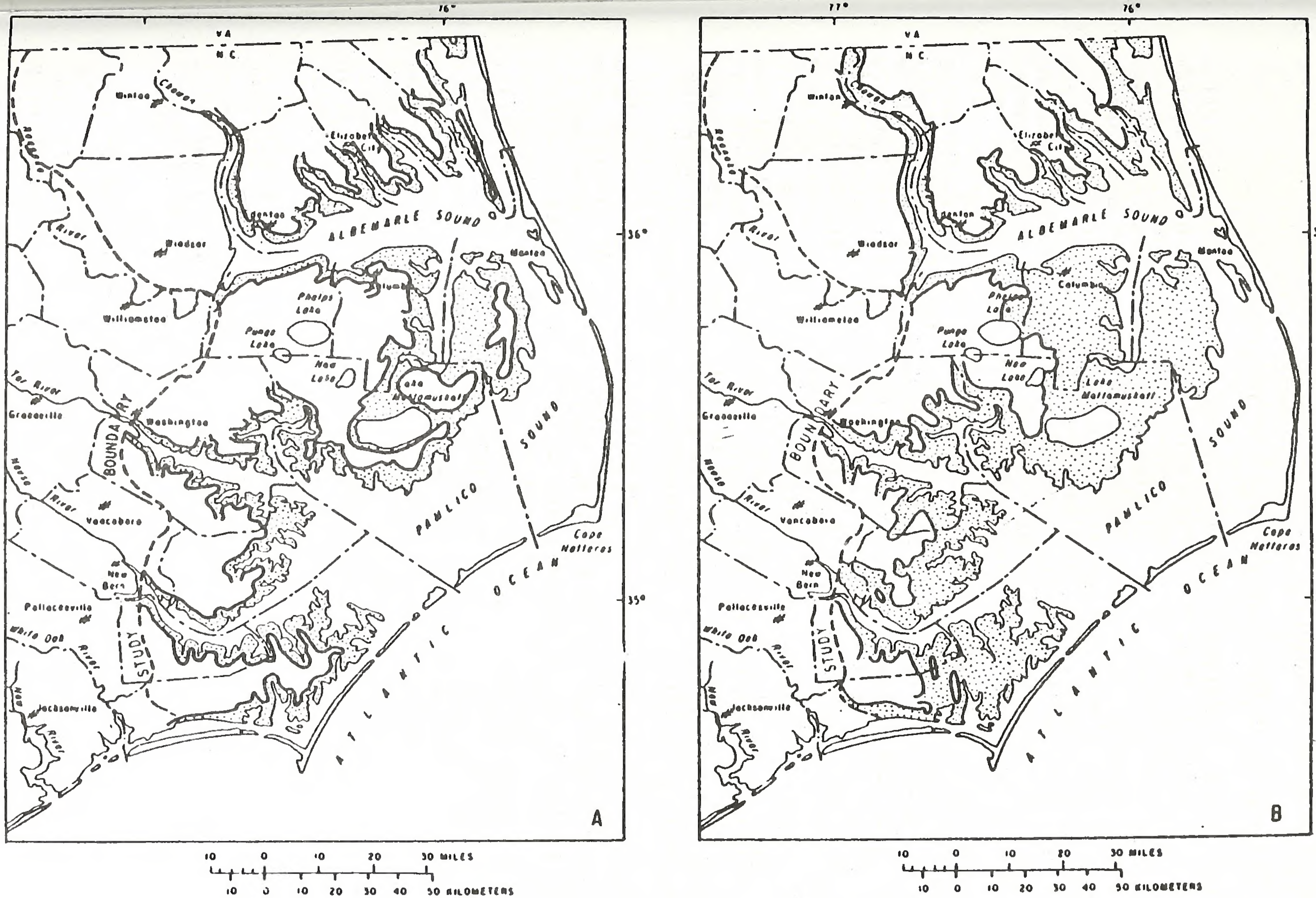

Figure 7.4A: Area subject to flood inundation caused by wind tides having A, 50% chance of being equalled or exceeded in any one year; B, 1% chance of being equalled or exceeded in any one year

(from Wilder, Robison and Lindskov, 1978)

7.5 Natural Area Inventory

7.5.1 Statement of the Problem/Data and Information Available

The North Carolina Coastal Plain contains about one million acres of wetland. Over the years many aspects of this ecosystem have been studied by the scientific community, yet no comprehensive picture of a single wetland has ever been developed. Little is truly known of the biotic and abiotic components of these wetlands. In addition, the processes that brought about their origin and development and which now control their maintenance are poorly understood. Where and how the wetlands fit into the overall natural scheme of the Coastal Plain is not known (Richardson, 1981; Ash et al., 1983).

Many of the large wetland tracts in the state, including the Green Swamp, Holly Shelter, Angola Bay, Hofmann Forest, Croatan National Forest, Alligator River National Wildlife Refuge and the Dismal Swamp are either partially or entirely under state, federal or private conservational ownership. These areas are at least partially protected, and are generally readily available for scientific research. The series of wetland tracts associated with the Alligator River drainage basin in Dare, Hyde, Tyrrell and Washington Counties is the largest and most unique, in terms of its origin and complex nature, in the state. This system, because of its overall size and remoteness, has been relatively inaccessible for research and, consequently, is the least understood of the North Carolina wetlands.

Despite the March, 1984, gift of 120,000 acres in Dare and Tyrrell Counties to the federal government to create the Alligator River National Wildlife Refuge, much of the land in the Alligator River drainage basin is still in private ownership and has been exploited to a much greater extent than the other large wetlands in the state. In a sense, it is the exploitation, and especially the recent development of extensive drainage systems and clearing of the land, that has opened the area for research. In the past ten years, this four-county area has been the focus of several large-scale overview studies, including Heath's 1975 work on the hydrology of the region; Daniel's 1978 work on the land use, land cover and drainage of the area; Ingram and Otte's 1982 report on the peat deposits located in the drainage basin; a series of county natural area reports by McDonald and Ash (1981) for Tyrrell County, Peacock and Lynch (1982a) for Dare County, and Lynch and Peacock (1982a and 1982b) for Hyde and Washington Counties; and Lukin and Mauger's 1983 environmental geologic atlas of the four-county area, which includes maps of the soils, drainage systems, land use and land cover, based on previous studies and on analyses of aerial photographs.

The development of this region has been proceeding at such a rapid pace that the scientific community rarely has the time or funding to achieve an understanding of the natural significance of an area before it has been substantially altered. Many questions concerning these wetlands should be answered before they are irreparably disturbed. The majority of the wetlands associated with the Alligator River drainage basin has already been altered to varying degrees. Most, if not all, of the forested tracts have been cut at least once. Large portions have been ditched and are being drained in an attempt to prepare the land for agriculture, silviculture or peat mining. Roads and drainage canals cross the paths of natural surface and subsurface water flow and have effectively altered the water regime in numerous areas.

Large portions of the Alligator River drainage basin now support either second growth swamp forest or shrub-dominated pocosin systems. No attempt has ever been made to reconstruct the original vegetational systems to determine how the wetlands have responded to alterations by man. It is not known how the present swamp forests resemble the original forests. If any last vestiges of virgin forests do exist, they have not been located. The pocosins are either primary natural systems or secondary systems that developed on cut-over land. No study, however, has attempted to differentiate the two. No comprehensive survey has been undertaken to determine the presence, location or size of populations of threatened or endangered plant or animal species, unique habitats, communities or disjunct systems.

The Alligator River drainage basin covers hundreds of square miles of land. This system contains tracts of wetland, up to tens of thousands of acres in size, that respond to different environmental factors. The physical, chemical and biological parameters of these tracts are poorly understood. It is not known how attempts at draining, clearing and developing portions of a single tract will influence the dynamics of the remaining undisturbed portions. The boundaries of these tracts are not even accurately delineated.

7.5.2 Recommended Approach

Before an area such as the Alligator River drainage basin is developed so extensively that it can no longer be considered natural, an attempt should be made to determine if the basin contains areas that are in some way unique, in terms of biological, hydrological, geological, pedological, chemical or other natural aspects of the system.

A tremendous amount of work would be required to develop a comprehensive understanding of the natural qualities of the Alligator River drainage system and, in particular, the regions that are prime candidates for development. Thus far, essentially all research has been restricted to areas of easy access, meaning areas that have already undergone some degree of disturbance. The areas that are least disturbed and, thus, least accessible, have been ignored. These undisturbed areas, however, are the locations in which discovery of natural features worthy of preservation is most likely.

A broad data base, including maps and several series of top quality, recent aerial photographs that cover the entire four-county region, is available. A comprehensive survey should be undertaken using these maps and photographs to locate areas of possible interest. Once these areas are differentiated, they must be analyzed first hand to determine their overall significance. The following steps should be taken:

1. A team of multidisciplined field scientists with a good working knowledge of ecology, botany, zoology, pedology, hydrology and basic geology, and capable of getting into these areas, must be assembled.
2. A standardized field inventory and classification system must be adopted. This would assure that all work is comprehensive, such that no natural process or feature is overlooked, and that all work is comparable.
3. A standardized set of criteria for determining the significance of each area investigated must be established. These criteria could then be used to determine the best of what is found.
4. A priority rating system must be developed, including significance priority, protection priority and management priorities, in order that sites deemed of some importance can be fitted not only into the natural realm, but also into the human realm.

The large size and natural quality of the Alligator River drainage basin almost guarantees that sites worthy of preservation will be found. It is possible that all of these sites will be on land that is either already preserved or on land, such as peat mining buffer strips, that would be somehow legally protected. It is probable, however, that numerous sites will be found on land slated for peat mining, timber production or agriculture. In such cases, the private landowners, representatives of the scientific community, local, state and federal agencies, and conservation groups will have to negotiate the ultimate use of these lands.

7.6 Air Quality

7.6.1 Statement of the Problem/Data and Information Available

Expansion of peat mining and processing from the scale of Scenario #1 (see sections 5.2.2 and 6.4) to that of Scenario #2 (see sections 5.2.3 and 6.4) has the potential to increase associated air pollutant emissions by about a factor of eight. This could lead to transgressions of air quality standards that are not jeopardized by the lower scale of development of Scenario #1. The pollutants of greatest concern are particulates and SO_2.

The initial PMA analysis of air quality impacts of a peat-to-methanol plant processing approximately 500,000 dry tons of peat annually (equivalent to the methanol production assumed in Scenario #1, Area 1) indicated that there should be no significant air quality degradation with such an operation (RGH, 1982). However, the potential impact of an eight-fold or greater expansion (as described in Scenario #2, Areas 1 and 3) has not been evaluated, largely because of the site specific requirements of any air quality modeling efforts. Such complex and expensive modeling is not required by state permitting procedures nor is it in an operator's self interest, given the hypothetical nature of such models not tied to specifically planned developments. Yet without such modeling it is very difficult to project the air quality impacts of large-scale peat mining and conversion. Model validation is also currently lacking.

7.6.2 Recommended Approach

Figure 7.6A shows isopleths of incremental additions to particulate concentrations (annual averages) in air resulting from a peat-to-methanol conversion plant processing 500,000 dry tons of peat per year (Scenario #1, Area 1). The data were provided by Koppers Company and were used in PMA's air quality permit application. Fugitive dust emissions from peat mining, transportation and away from plant storage are not included in these predictions. Contours for SO_2 are similar but about half the predicted particulate concentrations. In Figure 7.6B, the incremental particulate concentrations are estimated for an eight-fold increase in methanol production. The assumption was made that each of four facilities would emit twice the particulates of the Scenario #1 plant and that the four plants were widely spaced as shown. For comparison, the allowable PSD (Prevention of Significant Deterioration) increment for particulates in Class II areas is 19 $\mu g/M^3$.

This cursory analysis suggests that an eight-fold expansion of peat-to-methanol conversion plants would keep added particulate increments (and SO_2 increments) within permissible levels. The short term (e.g., 24-hour) average added increments is not so easily estimated and might approach permissible limits. It would be of value to model air quality impacts at this level of time resolution if long-term peat mining impacts are to be assessed. However, because of the sequential incremental development of peat processing plants and the individual separate permitting process for each, no single plant would transgress air quality standards because each has an individually applied PSD increment within a higher absolute air quality standard. If, however, peat mining in the region is considered to be a single air pollutant source (or the developments of a single owner/operator are so considered), then allowable increments should not be applied to each single facility as it comes on line (i.e., a bubble approach is required). This would require that state regulatory agencies change the way they evaluate the air quality impacts of facilities that develop sequentially.

More important from an air quality perspective is the problem of mining itself as a source of particulates. The air quality model calculations from mining operations on the scale of Scenario #1 do not predict transgressions of particulate standards at offsite locations. However, the emission rates on which the model calculations are based are highly uncertain and possibly unrealistically low. There is an urgent need to determine fugitive dust emission rates under the actual conditions proposed for milled peat mining as well as the impact of any control and amelioration methods. The studies required to better define these emission rates need not wait for actual mining to begin. The state Division of Environmental Management's (DEM) permitting process might require such studies of the already permitted mining companies without waiting for post hoc monitoring results after commencement of mining. Test plots on First Colony Farms (PMA) permitted property have already been of use in evaluating the impacts of mining on water quality. An analogous test system to evaluate dust emission rates and mitigative measures would seem to be feasible, at a reasonable cost, borne by one or more of the already permitted mining companies.

Because air quality permits are renewable yearly, such requirements could be readily incorporated in the near future. DEM's Air Quality Section seems cognizant of these problems and is encouraging a local monitoring network to evaluate fugitive dust emissions.

Because of the low height (as contrasted with a processing plant smoke stack) at which fugitive dust emissions will occur, their impact is likely to be very local and limited to areas immediately adjacent to mined lands. As a result, the contributions to air quality degradation of individual mining operations will be largely independent and non-additive. The need for multiple source modeling which exists for stack emission point sources is probably absent.

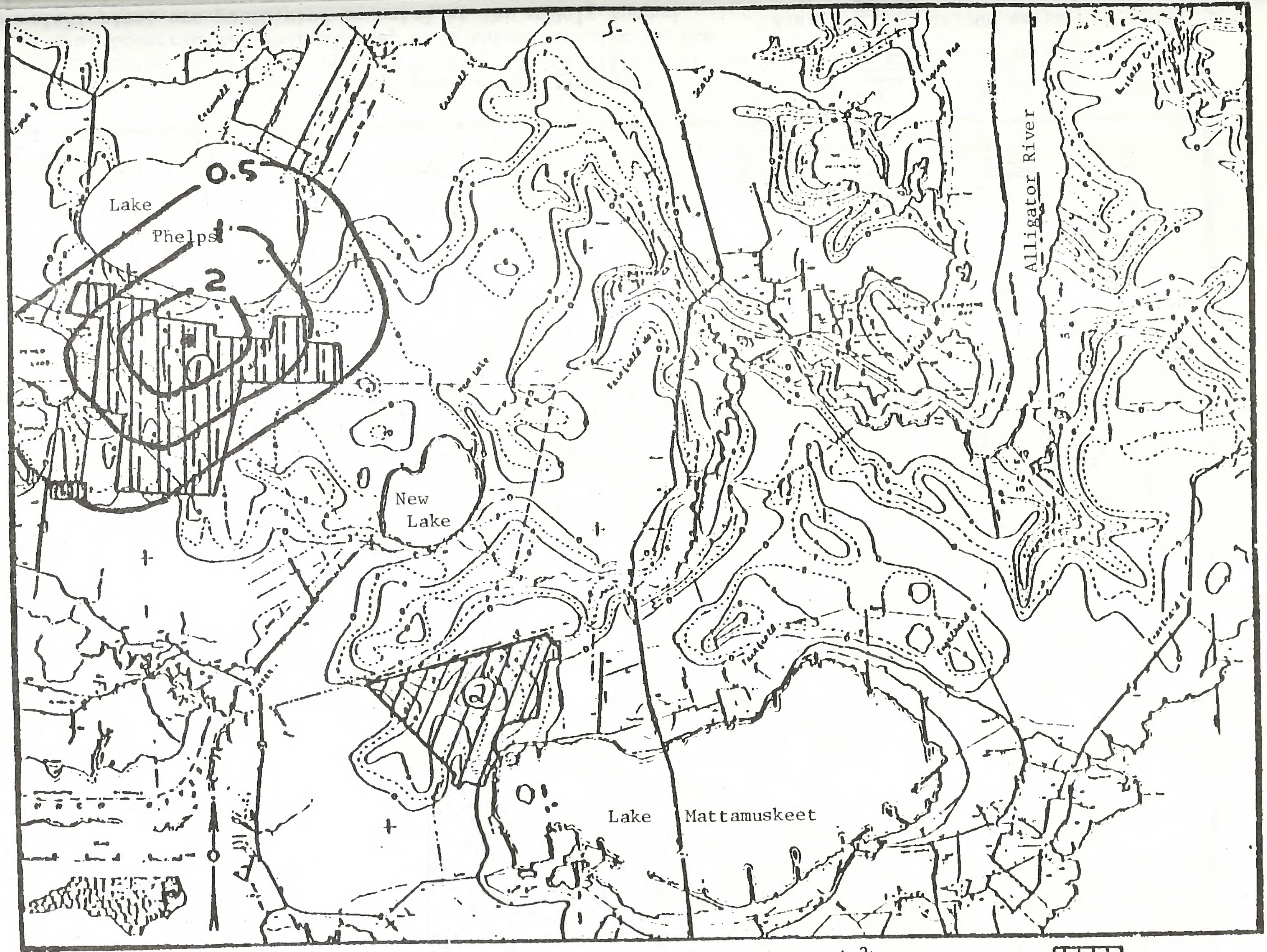

Figure 7.6A: Isopleths of annual average particulate concentrations ($\mu g/m^3$) predicted to be added by peat-to-methanol conversion at a plant the size of that postulated in Scenario #1.

Area 1 ▥ 15,818 ac.

Area 2 ▨ 7,142 ac.

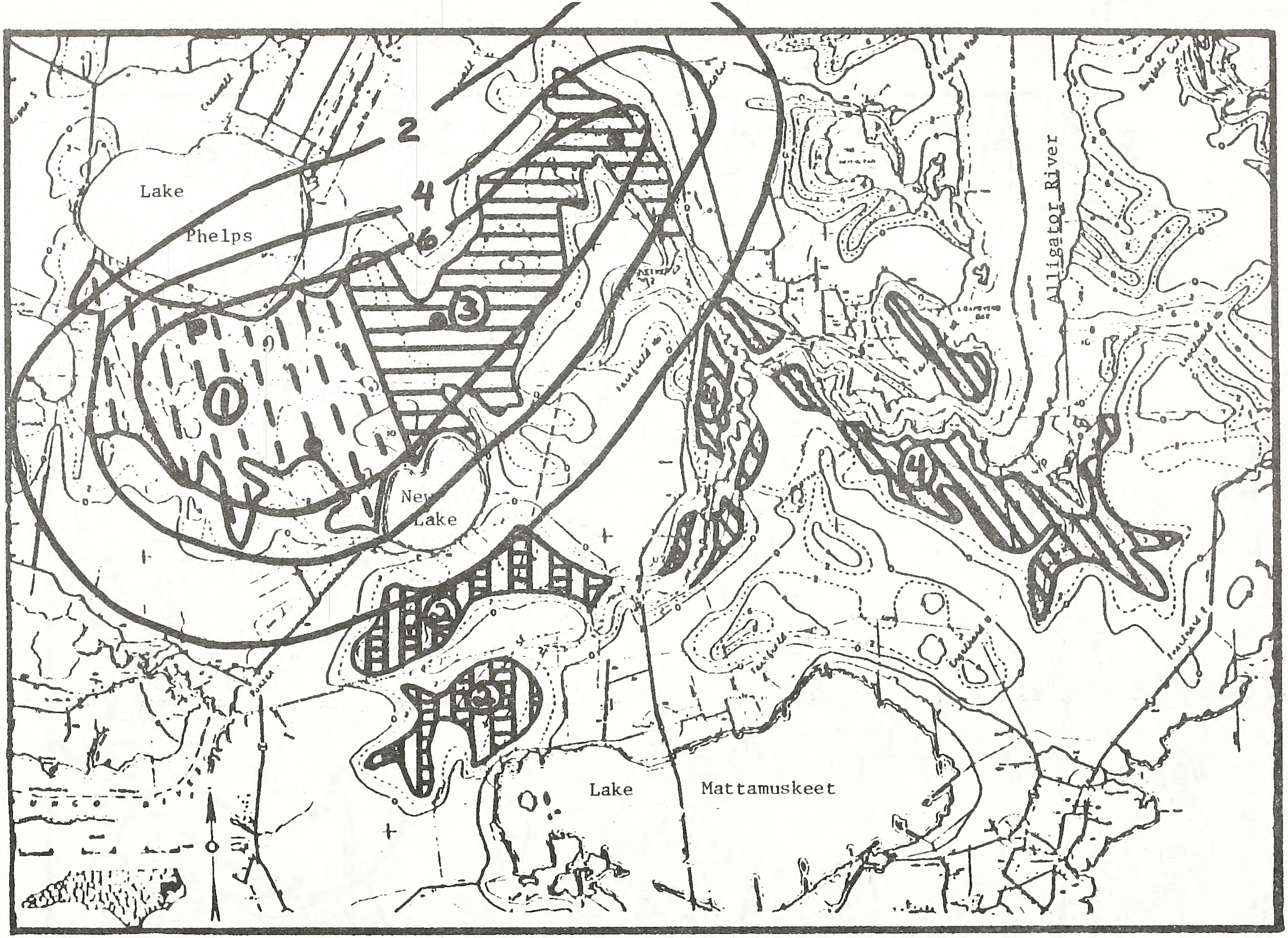

Figure 7.6B Isopleths of annual average particulate concentrations ($\mu g/m^3$) predicted to be added by peat-to-methanol facilities of the the size of Scenario#2. Four plants, each twice the size of the Scenario#1 plant are postulated to exist at the widely spaced sites shown.

Area 1	▥	30,000 acres
Area 2	▦	15,000 acres
Area 3	▤	26,000 acres
Area 4	▨	13,000 acres

7.7 Solid Wastes

7.7.1 Statement of the Problem/Data and Information Available

Peat on the Albemarle-Pamlico Peninsula contains on a dry weight basis approximately 6-10% ash. If oxidized completely, as in direct combustion or in conversion to methanol, peat produces very large quantities of ash or slag residues requiring disposal. Peat thus shares many properties with coal in terms of the volume and composition of its combustion wastes. The output from a methanol plant producing 60 million gallons of methanol per year has been estimated at approximately one million cubic feet of non-hazardous waste per year (PMA, 1983h). Greatly expanded peat to methanol conversion as described in Scenario #2 (see section 5.2.3) would produce up to seven million cubic feet of non-hazardous solid waste per year. Such volumes, if disposed of offsite as planned, would require great expansion of existing solid waste disposal capabilities on the peninsula.

In order to accommodate the solid wastes generated by a plant producing 60 million gallons of methanol annually in Washington County, the county's sanitary landfill would need to be expanded. Because the landfill is currently located on leased property and operated by an independent operator, the capacity for expansion on the larger scale of Scenario #2 is not certain and must be determined.

Preliminary tests of ash produced during pilot scale simulations of peat-to-methanol conversion have shown them to be rightly characterized as non-hazardous. However, these tests did not collect the smallest ash particles which are likely to contain the highest concentrations of some toxic trace elements. As a consequence, leachates from ash by-products have not been accurately characterized, with a probable underestimate of leachable toxic metal concentrations. In addition, most of the leachate tests were performed at pH levels higher than would be expected in percolating groundwater or local surface waters in which disposed ash is likely to be in contact. As a consequence, predicted leachable metal concentrations were further underestimated. Finally, the leachability of phosphorus from simulated ash was not determined.

The question of leachability is important because leached metals (or other elements) could enter groundwaters flowing from the disposal site. In addition, surface water contamination could result if onsite ash disposal by land application (as a soil amendment) or as roadfill is utilized as an alternative disposal approach. Leachable phosphorus in appreciable quantities would add to nutrient loads in runoff, increasing the potential for eutrophication of receiving waters. However, based on evidence derived from coal ashes, the ash contribution to phosphorus concentrations in runoff is not likely to be large.

7.7.2 Recommended Approach

There are thus two potential problems in solid waste disposal which will need solution before large scale utilization of peat in combustion processes can occur: 1) further characterization of the properties of leachates of real peat combustion ashes and 2) selection and evaluation of disposal sites.

Further characterizations of peat combustion ashes should include analysis of the very finest ash particles which were not collected in PMA's study (1983h) but which will be collected (e.g., by electrostatic precipitators) in an operational peat-to-methanol plant. These fine ashes are likely to contain higher concentrations of many trace elements and toxic metals in a more soluble form than those sampled by PMA (1983h). Phosphorus in leachates of these ashes should be measured. Leaching studies should be conducted at the low pH (3.5 to 5) occurring naturally in surface drainage and perhaps with the associated high concentrations of humic and fulvic acids which can readily complex many trace metals and increase their leachability from ashes. Leachability under anoxic, low redox potential conditions characteristic of groundwaters contacting landfills would also be useful.

These tests could be performed before actual operation of a peat-to-methanol conversion plant began. Once such a plant has begun operating, real ash and other solid waste could then be evaluated, providing information needed to assess larger scale peat mining for methanol production as hypothesized in Scenario #2.

If direct combustion of peat for thermal/electric generation is planned as another end use of mined peat, separate evaluation of resultant ashes and other solid wastes will be required, as the ashes produced will likely differ somewhat from those resulting from the peat-to-methanol conversion process.

Most of these solid waste characterization studies could be carried out as part of the normal pre-operational permitting process, without the need for special research programs. They require, however, an understanding of the chemical environments (e.g., low pH and redox potential and high dissolved organic content) of probable disposal sites in eastern North Carolina. Such characterization studies could be incorporated in future permitting requirements.

Site selection and evaluation for solid waste disposal should be given more consideration by both the operating companies and the state regulatory agencies. The ash materials resulting from peat combustion differ greatly from the usual materials disposed of in municipal sanitary landfills. Methods of disposal applied to the latter will not be appropriate for peat ashes. Coal ash disposal methods would provide a better model. The potential for groundwater and surface water contamination by trace elements leaching from buried ashes can not be evaluated until the ash leachates have been better characterized, as previously discussed.

The limited vertical topographic relief of the Coastal Plain, in association with the highly porous sandy soils and shallow water tables, limits the availability of good landfill sites. This may create problems if ash leachates are significantly more hazardous than initially predicted. Certainly the disposal sites selected should be well characterized in terms of their appropriateness for this class of solid waste. Utilization of the Washington County landfill could prove complicated if leachate problems develop as the liable party responsible for remedial action is not clearly defined. Is it the waste producer, Washington County, the private property owner of the site or the private waste disposal contractor?

Disposal of non-hazardous wastes onsite would clarify this responsibility issue. The use of solid waste for agricultural land treatment or roadfill as an alternative to offsite disposal should be encouraged, along with the necessary studies of the safety and feasibility of such an approach. This could readily be incorporated as a requirement in the normal state pre-operational permitting process.

Moreover, onsite disposal would obviate the problem of the large volumes of solid waste. It is unlikely that the Washington County landfill or other municipal landfills in the region have the capacity to accept the seven million cubic feet per year of waste that is estimated for the methanol production rate by year 20 described in Scenario #2 (see section 5.2.3.7).

7.8 Local Economics

7.8.1 Statement of the Problem

The analysis of the socioeconomic impacts of the scenarios (section 6.7) must be considered a preliminary estimate because it is based on 1) secondary data currently available for the area or 2) data developed in studies of mining in other parts of the country.

In addition, it was not possible within the time and resource limitations of this project to examine possible economic losses in the recreation, tourism and commercial and sport fishing sectors of the economy due to peat mining. In the section on estuarine impacts, approaches for estimating hydrodynamic and biological impacts are described. If harvestable finfish and shellfish stocks and flows are found to be impacted by peat mining, net economic returns of the commercial fishing sector may be affected. Economic returns generated by sports fishermen may also be affected if the probability of catch affects their expenditures. Recreation and tourism may be impacted for similar reasons and, in addition, are tied to the overall level of environmental quality in the region. Research is also needed on the economic impact of wildlife habitat changes on activities such as hunting and bird watching.

Another concern is the potential adverse fiscal effect of peat mining upon some county and city governments in the area surrounding the peat mining facility. Two basic concerns are: 1) that the benefits of peat mining will not be distributed to city and county governments in proportion to the costs incurred (the distribution issue) and 2) that revenues accruing to local governments from peat mining will lag cost incidence, thus leading to short-run cash flow problems (the revenue-lag issue). The demand for governmental services (e.g., water supply, wastewater disposal, solid waste disposal and education) generated by the immigration of individuals and families into the area to work at the peat mining facility (or to serve people who do) may result in governmental deficits that lead to increased tax rates or reduced quality of services for current residents.

The distribution issue arises because new residents may move into areas that do not benefit from tax revenues generated by the mining facility. The revenue-lag issue arises because governmental costs incurred while providing additional services to the increased number of residents must typically be incurred one or more years in advance of the receipt of local tax revenues or state aid designed to pay those costs. Research information is needed for city and county governments concerning (1) revenues that will be generated and (2) expenditures that will be incurred as a result of the peat mining activity.

7.8.2 Data and Information Available

PMA (1983g) has analyzed the socioeconomic impacts of a peat-to-methanol plant processing approximately 500,000 (dry) tons of peat per year.

Information in sufficient quantity is not currently available to model the cost and revenue impacts of peat mining at different scales on city and county governments. PMA (1983g) assessed in a general way the adequacy of services and the availability of excess capacity to serve larger populations in affected areas. However, cost estimates for services were not developed. Further, a more detailed analysis is required to estimate the fiscal impact upon all affected individual cities and individual counties. This level of detail is essential since each such level of government must tax residents to obtain revenues for operation. Any revenue shortfalls or lags will thus adversely affect current residents. Modeling of these impacts is possible, however, using data that can be obtained from state, city, county and industry sources.

Research concerning the potential impacts upon the recreation, tourism and commercial and sport fisheries sectors can utilize existing data as a base case, but will be dependent upon physical and biological impact information from hydrodynamic and hydrological modeling efforts (see sections 7.1 and 7.3) and from impact studies of participation in rereation, tourism and sport fishing. Most of the data required are not currently available.

7.8.3 Recommended Approach

Research required for a more complete analysis of the socioeconomic impacts of peat mining would include: 1) an independent evaluation of the socioeconomic data upon which PMA's (1983g) analyses of impacts were based; 2) an analysis of the economic feasibility of the peat-to-methanol conversion process; 3) generation of more detailed data for horticultural peat and peat for fuel operations; 4) a more detailed analysis of the effects of plant scale; and 5) the studies of impacts upon recreation, tourism and sport fisheries that are dependent upon responses of users to changes in the fishery and environmental quality. As noted earlier, these impacts are related to the physical and biological changes that occur but are dependent upon how users preceive these changes, how they adjust their expenditures on those activities accordingly or what they are willing to pay to maintain the "without project" level of environmental quality and fishery populations.

An estimate of the fiscal impact of peat mining upon city and county governments is also needed. (Estimates of the overall economic impacts would require a much more comprehensive model of the regional economy than would be provided by the fiscal impacts analysis proposed here.)

Two simulation models are necessary. One would simulate the taxes paid by the peat mining facility (for example, corporate property, sales and income taxes, and the unemployment tax). This model would allow for assessing the impact of changes in these tax rates and for simulating alternative plant production levels that enter the equation determining local tax revenues. The model would also be capable of simulating the impact of new taxes that might be considered to help generate local funds needed to serve new residents (e.g., severance taxes on peat mined or a tax on the final products of the plant). The focus of the model would be on the impact of various tax laws on the peat mining facility.

The second simulation model would examine the overall fiscal impact of peat mining upon various levels of state and local government in the study area. Revenues to these levels of government will be a function of their tax rates, their share of state revenues determined by state aid formulas and the manner in which they are impacted by the peat mining facilities' activities (for example, the increase in their tax base, population, new students, etc.). This revenue information would be used as input in the analysis of the net benefits (revenues less service costs) resulting from peat mining activities. A key element in this portion of the analysis would be the need for new or expanded services. The focus of this model would thus be each city and county government in the effected area. The model would also allow for estimating the level of tax revenues paid by employees (e.g., income, sales, property and excise taxes).

Throughout the analysis, assumptions must be made for certain parameters, for example, the distribution of new residents attracted by the facility. The models would allow for easy sensitivity analysis of these factors to estimate the impact of alternative scenarios.

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10. APPENDICES

10.1 Habitat Type/Land Use Data
(based on Lukin and Mauger, 1983)

Table 10.1A: Scenarios #1 and #3-- Approximate acreages of peatland by habitat type/land use category at year 0

Land Use Category	Area 1 Acres	Area 1 %	Area 2 Acres	Area 2 %
Residential development	0	0	0	0
Roads and rights-of-way	0	0	0	0
Other developed areas	0	0	0	0
Agricultural land	2,848*	18	1,071	15
Deciduous forest	0	0	0	0
Evergreen forest	0	0	929	12.5
Mixed forest	0	0	0	0
White cedar swamp	0	0	0	0
Mixed swamp forest	0	0	71	1
Disturbed land:				
a) Transitional/field ditched	8,700	54	1,071	15
b) Ditched pocosin, not otherwise disturbed	0	0	1,857	26
High pocosin	633	4	1,214	17
Low pocosin	3,005	20	929	12.5
Bay forest	0	0	0	0
Water (incl. canals), marsh	316	2	0	0
Active peat mine	0	0	0	0
Inactive peat mine	316	2	0	0
Total Acres	15,818		7,142	

* Not currently in production, but soon to be put into agricultural production (S. Barnes, First Colony Farms, personal communication, 1983).

Table 10.1B: Scenario #2-- Approximate acreages of peatland by land use category at year 0

Land Use Category	Area 1 Acres	Area 1 %	Area 2 Acres	Area 2 %	Area 3 Acres	Area 3 %	Area 4 Acres	Area 4 %
Residential development	0	0	0	0	0	0	0	0
Roads and rights-of-way	0	0	0	0	0	0	0	0
Other developed areas	0	0	0	0	0	0	0	0
Agricultural land*	2,700	9	1,200	8	0	0	260	2
Deciduous forest	0	0	0	0	0	0	0	0
Evergreen forest	0	0	1,200	8	0	0	0	0
Mixed forest	0	0	0	0	0	0	0	0
White cedar swamp	0	0	0	0	0	0	130	1
Mixed swamp forest	0	0	450	3	5,460	21	3,640	28
Disturbed land:								
a) Transitional field ditched	9,600	32	300	2	780	3	650	5
b) Ditched pocosin, not otherwise disturbed	0	0	1,800	12	0	0	650	5
High pocosin	3,900	13	2,700	18	15,600	60	2,990	23
Low pocosin	13,200	44	7,200	48	4,160	16	3,640	28
Bay forest	0	0	0	0	0	0	910	7
Water (incl. canals)/marsh	300	1	150	1	0	0	130	1
Active peat mine	0	0	0	0	0	0	0	0
Inactive peat mine	300	1	0	0	0	0	0	0
Total Acres	30,000		15,000		26,000		13,000	

* Difference between acres in agricultural production in Scenarios #1 and #2 (Areas 1 and 2) is due to the fact that acreage outside the 4-foot peat thickness contour included in Scenario #1 (Areas 1 and 2) was not necessarily included in Scenario #2 (Areas 1 and 2).

10.2 Appendix for Section 6.1.1: Agriculture

WHEAT AND SOYBEANS, DOUBLE-CROPPED: Estimated revenue, operating expenses, annual ownership costs and net revenue per acre

Category	Units	Price	Quantity	Value	Your Value
Production:					
Wheat	Bu.	$ 3.60	50.000	$180.00	
Soybean	Bu.	5.85	25.000	146.25	
Total Receipts				$326.25	
Operating Inputs:					
Lime applied	Tons	$26.00	0.333	$ 8.66	
Seed wheat	Bu.	8.00	1.500	12.00	
5-15-30, bulk	Cwt.	9.33	4.000	37.32	
Dry fertilizer spreading	Acre	5.50	2.000	11.00	
33.5% Amonium nitrate, bulk[a]	Cwt.	10.50	1.791	18.81	
Post-emerge herbicide	Acre	2.59	1.000	2.59	
Soybean seed	Bu.	10.50	0.800	8.40	
Soybean inoculant	Bu.	1.85	0.800	1.48	
Pre-emerge herbicide	Acre	17.02	1.000	17.02	
Nematicide[b]	Acre	34.05	1.000	34.05	
Insecticide[b]	Acre	3.47	1.000	3.47	
Insecticide applied by plane[b]	Acre	4.50	1.000	4.50	
Tractor fuel and lube cost	Acre			6.69	
Tractor repair cost	Acre			2.59	
Machinery fuel and lube cost	Acre			6.36	
Machinery repair cost	Acre			9.57	
Total operating cost				$184.91	
Returns to land, labor, capital, machinery, overhead, and management				$141.34	
Capital cost:					
Annual operating capital		$ 0.14	$ 55.143	$ 7.72	
Tractor investment		0.14	39.026	5.46	
Machinery investment		0.14	189.571	26.54	
Total interest charge				$ 39.72	
Returns to land, labor, machinery, overhead, and management				$101.62	
Ownership cost: (Depreciation, taxes, insurance)					
Tractor	Dol.			$ 4.42	
Machinery	Dol.			29.18	
Total ownership cost				$ 33.60	
Returns to land, labor, overhead, and management				$ 68.02	
Labor cost:					
Machinery labor	Hr.	$ 4.25	2.972	$ 12.63	
Total labor cost				$ 12.63	
Returns to land, overhead, and management				$ 55.39	

Prepared by R. E. Jarrett, E. J. Dunphy, Crop Science Extension Specialists, and D. F. Neuman, Extension Economist.

[a] Increase nitrogen application by 20 pounds in Coastal Plain.

[b] An insecticide and nematicide will not likely be needed in the Piedmont.

WHEAT/SO BMS 1

WHEAT AND SOYBEANS, DOUBLE-CROPPED. Estimated Revenue, Operating Expenses, Annual Ownership Costs and Net Revenue Per Acre.

LINE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
PRODUCTION			Number of Units						
1 Wheat	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0
2 Soybeans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	OCT	NOV	DEC	PRICE	WEIGHT	UNIT CODE	ITEM CODE	TP	CM
			Number of Units						
1 Wheat	0.0	0.0	0.0	3.60	0.0	2.00	66.00	2.00	0.0
2 Soybeans	0.0	25.00	0.0	5.85	0.0	2.00	86.00	2.00	0.0

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Operating Inputs			Rate/Unit						
3 Lime, Applied	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 Seed Wheat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 5-15-30, Bulk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 Dry Fert Spread	0.0	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 33.5 Ammonium Nl	0.0	1.79	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 Post Emerge Herb	0.0	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 Soybean Seed	0.0	0.0	0.0	0.0	0.0	0.0	0.80	0.0	0.0
10 Soybean Inocul	0.0	0.0	0.0	0.0	0.0	0.0	0.80	0.0	0.0
11 Pre-Emerge Herb	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0	0.0
12 Nematicide	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0	0.0
13 Insecticide	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0
14 Insecticide Appl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0

	OCT	NOV	DEC	PRICE	WEIGHT	UNIT CODE	ITEM CODE	TP	CM
Operating Inputs			Rate/Unit						
3 Lime Applied	0.33	0.0	0.0	26.00	0.0	3.00	229.00	3.00	0.0
4 Seed Wheat	1.50	0.0	0.0	8.00	0.0	2.00	174.00	3.00	0.0
5 5-15-30, Bulk	2.00	0.0	0.0	9.33	0.0	16.00	209.00	3.00	0.0
6 Dry Fert Spread	1.00	0.0	0.0	3.50	0.0	7.00	230.00	3.00	0.0
7 33.5 Ammonium Nl	0.0	0.0	0.0	10.50	0.0	16.00	225.00	5.00	0.0
8 Post Emerge Herb	0.0	0.0	0.0	2.59	0.0	7.00	256.00	3.00	0.0
9 Soybean Seed	0.0	0.0	0.0	10.50	0.0	2.00	177.00	3.00	0.0
10 Soybean Inocul	0.0	0.0	0.0	1.83	0.0	2.00	275.00	3.00	0.0
11 Pre-Emerge Herb	0.0	0.0	0.0	17.02	0.0	7.00	234.00	3.00	0.0
12 Nematicide	0.0	0.0	0.0	34.03	0.0	7.00	266.00	3.00	0.0
13 Insecticide	0.0	0.0	0.0	3.47	0.0	7.00	240.00	3.00	0.0
14 Insecticide Appl	0.0	0.0	0.0	4.50	0.0	7.00	269.00	3.00	0.0

Monthly Summary of Receipts and Expenses

CATEGORY	UNIT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Total Receipts	Acre	0.0	0.0	0.0	0.0	0.0	180.00	0.0	0.0	0.0	0.0	146.25	0.0	326.25
Total Expenses	Acre	0.0	29.09	0.0	0.0	0.0	7.40	67.55	7.97	0.0	67.46	5.09	0.0	184.91
Returns to Land, Labor, Capital, Machinery, Overhead, Risk, and Management														141.34
ANNUAL CAPITAL	Dol.	0.0	21.82	0.0	0.0	0.0	3.08	22.63	1.99	0.0	5.62	0.0	0.0	55.14

Labor Requirements by Month

MACHINERY LABOR	Hr	0.0	0.32	0.0	0.0	0.0	0.81	0.78	0.0	0.0	0.59	0.45	0.0	2.97

Machinery Fixed and Variable Costs Per Hour

MACHINE	CODE	DEPR	INSUR	TAX	TOTAL FIXED	REPAIR	FUEL	LUB	TOTAL VARIABLE	INT	HR/TIME
Tractor (3)	3	2.84	0.23	0.13	3.19	1.87	4.19	0.63	6.69	3.94	1.00
Pickup Truck	17	2.42	0.10	0.05	2.58	1.30	3.44	0.52	3.26	1.80	1.00
Truck	18	4.73	0.24	0.15	5.11	5.30	3.04	0.46	8.79	4.14	1.00
Grain Combine SG	20	34.60	1.98	1.16	37.74	7.25	6.67	1.00	14.93	34.61	0.25
Tandem Disc	39	3.87	0.23	0.14	4.23	1.01	0.0	0.0	1.01	4.03	0.17
Sect. Harrow	45	0.49	0.03	0.02	0.53	0.12	0.0	0.0	0.12	0.30	0.17
Grain Drill	50	7.40	0.44	0.28	8.12	1.91	0.0	0.0	1.91	7.71	0.22
Sprayer TM 1100A	70	0.65	0.03	0.02	0.70	0.67	0.0	0.0	0.67	0.37	0.16
Corn Planter/ATT	48	6.11	0.36	0.23	6.70	4.29	0.0	0.0	4.29	6.38	0.32
Sprayer TM 110	71	0.65	0.03	0.02	0.70	0.67	0.0	0.0	0.67	0.57	0.32
Roll Cultivator	63	3.06	0.18	0.11	3.35	0.35	0.0	0.0	0.59	3.20	0.22
Sprayer TM 110	72	0.65	0.03	0.02	0.70	1.84	0.0	0.0	1.84	0.37	0.22

OPERATION	ITEM NO.	DATE	TIMES OVER	LABOR HOURS	MACHINE HOURS	FUEL-OIL-LUB. REPAIR PER ACRE	FIXED COSTS PER ACRE
Sprayer TM 1100A	3,70	FEB	1.00	0.198	0.164	1.31	1.49
Truck	18	FEB	0.10	0.120	0.100	0.88	0.92
Tandem Disc	3,39	JUN	1.00	0.204	0.169	1.41	2.72
Sect Harrow	45	JUN	1.00	0.0	0.169	0.02	0.17
Grain Combine SG	20	JUN	1.00	0.303	0.253	3.77	10.29
Truck	18	JUN	0.25	0.300	0.250	2.20	2.31
Corn Planter	3,48	JUL	1.00	0.395	0.323	3.78	6.80
Sprayer TM 1100A	71	JUL	1.00	0.0	0.325	0.22	0.41
Roll Cultivator	3,63	JUL	1.00	0.262	0.217	1.67	3.12
Sprayer TM 110	72	JUL	1.00	0.0	0.217	0.40	0.28
Truck	18	JUL	0.10	0.120	0.100	0.88	0.87
Tandem Disc	3,39	OCT	1.00	0.204	0.169	1.41	2.72
Sect Harrow	45	OCT	1.00	0.0	0.169	0.02	0.17
Grain Drill	3,50	OCT	1.00	0.264	0.218	2.02	3.17
Pickup Truck	17	OCT	0.10	0.120	0.100	0.55	0.44
Grain Combine SG	20	NOV	1.00	0.303	0.253	3.77	10.29
Truck	18	NOV	0.13	0.150	0.130	1.32	1.39
TOTAL				2.972	3.344	25.61	65.56

WHEAT AND SOYBEANS, DOUBLE-CROPPED: Effect of varying rates of production of wheat and soybeans on net revenue to land, overhead and management (with wheat price at $3.60 per bushel and soybean price at $5.85 per bushel)

Rate of production of soybeans	Total cost per acre	Rate of production of wheat		
		40 bu.	50 bu.	60 bu.
20 bu.	$270.86	$ -9.86	$ 26.14	$ 62.14
25 bu.	270.86	19.39	55.39	91.39
30 bu.	270.86	48.64	84.64	120.64

CORN (COASTAL PLAIN--NONIRRIGATED): Estimated revenue, operating expenses, annual ownership costs and net revenue per acre

Category	Units	Price	Quantity	Value	Your Value
Production:					
Corn	Bu.	$ 2.26[a]	115.000	$259.90	
Total Receipts				$259.90	
Operating inputs:					
Lime applied	Tons	$26.00	0.333	$ 8.66	
Seed corn	Lbs.	1.26	16.000	20.16	
0-0-60, bulk	Cwt.	8.75	2.000	17.50	
Dry fertilizer spreading	Acre	5.50	1.000	5.50	
30% nitrogen solution[b]	Cwt.	7.16	4.670	33.44	
Pre-emerge herbicide	Acre			14.43	
Post-emerge herbicide	Acre			12.07	
Insecticide and nematicide	Acre			9.25	
Liquid nitrogen, custom applied	Acre	5.25	2.00	10.50	
Tractor fuel and lube cost	Acre			5.64	
Tractor repair cost	Acre			2.12	
Machinery fuel and lube cost	Acre			4.06	
Machinery repair cost	Acre			6.72	
Total operating cost				$150.05	
Returns to land, labor, capital, machinery, overhead, and management				$109.85	
Capital cost:					
Annual operating capital		$ 0.14	$ 64.641	$ 9.04	
Tractor investment		0.14	31.890	4.46	
Machinery investment		0.14	123.338	17.27	
Total interest charge				$ 30.77	
Returns to land, labor, machinery, overhead, and management				$ 79.08	
Ownership cost: (Depreciation, taxes, insurance)					
Tractor	Dol.			$ 3.61	
Machinery	Dol.			19.03	
Total ownership cost				$ 22.64	
Returns to land, labor, overhead, and management				$ 56.44	
Labor cost:					
Machinery labor	Hr.	$ 4.25	2.188	$ 9.30	
Total labor cost			2.188	$ 9.30	
Returns to land, overhead, and management				$ 47.14	

Prepared by J. R. Anderson, Jr., Crop Science Extension Specialist and D. F. Neuman, Extension Economist.

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[a] Based on $2.55 price, 20% moisture at harvest and 2.5% price discount for each percent moisture over 15.5%.

[b] Nitrogen level is based [illegible].

CORN (COASTAL PLAIN--NONBILLBUG AREAS): Estimated Revenue, Operating Expenses, Annual Ownership Costs and Net Revenue Per Acre.

LINE PRODUCTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
			Number of Units						
1 Corn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	115.00
	OCT	NOV	DEC	PRICE	WEIGHT	UNIT CODE	ITEM CODE	TP	CM
			Number of Units						
1 Corn	0.0	0.0	0.0	2.26	0.0	2.00	62.00	2.00	0.0

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Operating Inputs			Rate/Unit						
2 Lime, Applied	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 Seed Corn	0.0	0.0	0.0	16.00	0.0	0.0	0.0	0.0	0.0
4 0-0-60, Bulk	0.0	0.0	2.00	0.0	0.0	0.0	0.0	0.0	0.0
5 Dry Fert Spread	0.0	0.0	1.00	0.0	0.0	0.0	0.0	0.0	0.0
6 30% Nit Solut	0.0	0.0	0.0	2.75	1.92	0.0	0.0	0.0	0.0
7 Cus App Liq Nit	0.0	0.0	0.0	1.00	1.00	0.0	0.0	0.0	0.0
8 Pre-Emerg Herb	0.0	0.0	0.0	1.00	0.0	0.0	0.0	0.0	0.0
9 Post Emerge Herb	0.0	0.0	0.0	0.0	1.00	0.0	0.0	0.0	0.0
10 Insect & Nemat	0.0	0.0	0.0	1.00	0.0	0.0	0.0	0.0	0.0

	OCT	NOV	DEC	PRICE	WEIGHT	UNIT CODE	ITEM CODE	TP	CM
Operating Inputs			Rate/Unit						
2 Lime, Applied	0.33	0.0	0.0	26.00	0.0	3.00	229.00	3.00	0.0
3 Seed Corn	0.0	0.0	0.0	1.25	0.0	12.00	171.00	3.00	0.0
4 0-0-60, Bulk	0.0	0.0	0.0	8.73	0.0	16.00	208.00	3.00	0.0
5 Dry Fert Spread	0.0	0.0	0.0	5.50	0.0	7.00	230.00	3.00	0.0
6 30% Nit Solut	0.0	0.0	0.0	7.16	0.0	16.00	226.00	3.00	0.0
7 Cus App Liq Nit	0.0	0.0	0.0	3.25	0.0	7.00	237.00	3.00	0.0
8 Pre-Emerg Herb	0.0	0.0	0.0	14.46	0.0	7.00	250.00	3.00	0.0
9 Post Emerge Herb	0.0	0.0	0.0	12.07	0.0	7.00	256.00	3.00	0.0
10 Insect & Nemat	0.0	0.0	0.0	9.20	0.0	7.00	230.00	3.00	0.0

Monthly Summary of Receipts and Expenses

CATEGORY	UNIT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Total Receipts	Acre	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	259.90	0.0	0.0	0.0	259.90
Total Expenses	Acre	0.0	0.0	28.38	71.53	31.07	0.0	0.0	0.0	8.67	12.21	0.0	0.0	150.03
Returns to Land, Labor, Capital, Machinery, Overhead, Risk, and Management														109.83
ANNUAL CAPITAL	Dol.	0.0	0.0	13.29	29.81	10.36	0.0	0.0	0.0	0.0	11.19	0.0	0.0	64.64

Labor Requirements by Month

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
MACHINERY LABOR	Hr	0.0	0.0	0.33	0.36	0.0	0.0	0.0	0.0	0.96	0.51	0.0	0.0	2.16

Machinery Fixed and Variable Costs Per Hour

MACHINE	CODE	DEPR	INSUR	TAX	TOTAL FIXED	REPAIR	FUEL	LUB	TOTAL VARIABLE	INT	HR/TIME
Tractor (6)	4	2.33	0.19	0.10	2.62	1.54	3.67	0.55	5.76	3.24	1.00
Tractor (8)	8	4.56	0.38	0.20	5.12	3.02	6.81	1.02	10.86	6.33	1.00
Pickup Truck	17	2.42	0.10	0.06	2.58	1.30	3.46	0.52	5.28	1.80	1.00
Truck	18	4.73	0.24	0.15	5.11	5.30	3.04	0.46	8.79	4.14	1.00
Corn/Bean Combine	21	35.04	2.01	1.17	38.21	7.38	5.24	0.79	13.41	35.11	0.32
Tandem Disc	41	7.48	0.45	0.28	8.21	1.92	0.0	0.0	1.92	7.79	0.10
Ripper-Bedder	33	2.84	0.17	0.11	3.12	0.72	0.0	0.0	0.72	2.85	0.18
Corn Pl w/Row Shaper	46	6.69	0.41	0.28	7.95	4.81	0.0	0.0	4.81	7.18	0.20
Bush Hog	82	1.11	0.06	0.04	1.22	0.40	0.0	0.0	0.40	1.13	0.33

OPERATION	ITEM NO.	DATE	TIMES OVER	LABOR HOURS	MACHINE HOURS	FUEL-OIL-LUB. REPAIR PER ACRE	FIXED COSTS PER ACRE
Tandem Disc	9,41	OCT	1.00	0.117	0.097	1.35	2.70
Bush Hog	4,82	OCT	1.00	0.396	0.327	2.21	2.86
Tandem Disc	9,41	MAR	1.00	0.117	0.097	1.35	2.70
Ripper-Bedder	9,33	MAR	1.00	0.213	0.176	2.23	3.20
Corn Pl w/Row Shaper	4,46	APR	1.00	0.242	0.200	2.23	4.23
Pickup Truck	17	APR	0.10	0.120	0.100	0.53	0.44
Corn/Bean Combine	21	SEP	1.00	0.362	0.318	4.27	23.33
Truck	18	SEP	0.50	0.600	0.500	4.40	4.62
TOTAL				2.167	1.815	18.57	40.37

CORN (COASTAL PLAIN--NONBILLBUG AREAS): Effect of varying rates of production and prices on net revenue to land, overhead and management

Rate of production	Total cost per acre	Price per bushel[a]		
		$1.82	$2.26	$2.71
80 bu.	$208.01	$ -62.41	$ -27.21	$ 8.79
115 bu.	212.76	- 3.46	47.14	98.89
140 bu.	222.31	32.49	94.09	157.09

[a] Based upon 20 percent moisture content at harvest, 2.5 percent price discount for each percent moisture over 15.5, and prices of $2.05, $2.55 and $3.05 respectively.

WHEAT AND SOYBEANS, DOUBLE-CROPPED: Estimated revenue, operating expenses, annual ownership costs and net revenue per acre

Category	Units	Price	Quantity	Value	Your Value
Production:					
Wheat	Bu.	$ 4.00	50.000	$180.00	200.00
Soybean	Bu.	6.75	30.000	146.25	202.50
Total Receipts				$326.25	402.50
Operating inputs:					
Lime applied	Tons	$26.00	0.333	$ 8.66	
Seed wheat	Bu.	8.00	1.500	12.00	
5-15-30, bulk	Cwt.	9.33	4.000	37.32	
Dry fertilizer spreading	Acre	5.50	2.000	11.00	
33.5% Amonium nitrate, bulk[a]	Cwt.	10.50	1.791	18.81	
Post-emerge herbicide	Acre	2.59	1.000	2.59	
Soybean seed	Bu.	10.50	0.800	8.40	
Soybean inoculant	Bu.	1.85	0.800	1.48	
Pre-emerge herbicide	Acre	17.02	1.000	17.02	
Nematicide[b]	Acre	34.05	1.000	34.05	
Insecticide[b]	Acre	3.47	1.000	3.47	
Insecticide applied by plane[b]	Acre	4.50	1.000	4.50	
Tractor fuel and lube cost	Acre			6.69	
Tractor repair cost	Acre			2.59	
Machinery fuel and lube cost	Acre			6.36	
Machinery repair cost	Acre			9.57	
Total Operating cost				$184.91	
Returns to land, labor, capital, machinery, overhead, and management				$217.59	
Capital cost:					
Annual operating capital		$ 0.14	$ 55.143	$ 7.72	
Tractor investment		0.14	39.026	5.46	
Machinery investment		0.14	189.571	26.54	
Total interest charge				$ 39.72	
Returns to land, labor, machinery, overhead, and management				$177.87	
Ownership cost: (Depreciation, taxes, insurance)					
Tractor	Dol.			$ 4.42	
Machinery	Dol.			29.18	
Total ownership cost				$ 33.60	
Returns to land, labor, overhead, and management				$144.27	
Labor cost:					
Machinery labor	Hr.	$ 4.25	2.972	$ 12.63	
Total labor cost				$ 12.63	
Returns to land, overhead, and management				$131.65	

Prepared by R. F. Jarrett, E. J. Dunphy, Crop Science Extension Specialists, and D. F. Neuman, Extension Economist.

[a] Increase nitrogen application by 20 pounds in Coastal Plain.

[b] An insecticide and nematicide will not likely be needed in the Piedmont.

SOYBEANS: Estimated revenue, operating expenses, ownership costs and net revenue per acre

Category	Units	Price	Quantity	Value	Your Value
Production					
Soybean	Bu.	$ 5.85	35.000	$204.75	
Total Receipts				$204.75	
Operating Inputs:					
Soybean seed	Bu.	$10.50	0.800	$ 8.40	
0-10-20, bulk	Cwt.	6.55	3.000	19.65	
Dry fertilizer spreading	Acre	5.50	1.000	5.50	
Lime applied	Tons	26.00	0.333	8.66	
Soybean inoculant	Bu.	1.85	0.800	1.48	
Pre-emerge herbicide	Acre			17.02	
Post-emerge herbicide	Acre			14.76	
Nematicide material[a]	Acre			34.05	
Insecticide	Acre			3.47	
Insecticide applied by air[a]	Acre			4.50	
Tractor fuel and lube cost	Acre			6.49	
Tractor repair cost	Acre			2.95	
Machinery fuel and lube cost	Acre			3.71	
Machinery repair cost	Acre			6.84	
Total operating cost				$137.48	
Returns to land, labor, capital, machinery, overhead, and management				$ 67.27	
Capital cost:					
Annual operating capital		$ 0.14	$ 60.317	$ 8.44	
Tractor investment		0.14	44.271	6.20	
Machinery investment		0.14	128.707	18.02	
Total interest charge				$ 32.66	
Returns to land, labor, machinery, overhead, and management				$ 34.61	
Ownership cost: (Depreciation, taxes, insurance)					
Tractor	Dol.			$ 5.01	
Machinery	Dol.			19.78	
Total ownership cost				$ 24.79	
Returns to land, labor, overhead, and management				$ 9.32	
Labor cost:					
Machinery labor	Hr.	$ 4.25	2.299	$ 9.77	
Total labor cost				$ 9.77	
Returns to land, overhead, and management				$ [illegible]	

Prepared by E. J. Dunphy, Crop Science Extension Specialists, and [illegible]. Neuner, Extension Economist.

[a] An insecticide and nematicide are not likely to be needed in the Piedmont.

SOYBEANS.1

SOYBEANS: Estimated Revenue, Operating Expenses, Ownership Costs and Net Revenue Per Acre.

LINE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
PRODUCTION			Number of Units						
1 Soybean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	OCT	NOV	DEC	PRICE	WEIGHT	UNIT CODE	ITEM CODE	TP	CN
			Number of Units						
1 Soybean	0.0	35.00	0.0	5.85	0.0	2.00	86.00	2.00	0.0

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Operating Inputs			Rate/Unit						
2 Soybean Seed	0.0	0.0	0.0	0.0	0.83	0.0	0.0	0.0	0.0
3 Seed Treatment	0.0	0.0	0.0	0.0	0.80	0.0	0.0	0.0	0.0
4 0-10-20, Bulk	0.0	0.0	0.0	3.00	0.0	0.0	0.0	0.0	0.0
5 Dry Fert Spread	0.0	0.0	0.0	1.00	0.0	0.0	0.0	0.0	0.0
6 Lime, Applied	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 Pre-Emerg Herb	0.0	0.0	0.0	0.0	1.00	0.0	0.0	0.0	0.0
8 Post Emerge Herb	0.0	0.0	0.0	0.0	0.0	1.00	0.0	0.0	0.0
9 Nematicide	0.0	0.0	0.0	0.0	1.00	0.0	0.0	0.0	0.0
10 Insecticide-----	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0
11 Insecticide AP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0
	OCT	NOV	DEC	PRICE	WEIGHT	UNIT CODE	ITEM CODE	TP	CN
Operating Inputs			Rate/Unit						
2 Soybean Seed	0.0	0.0	0.0	10.50	0.0	2.00	177.00	5.00	0.0
3 Seed Treatment	0.0	0.0	0.0	1.65	0.0	2.00	262.00	3.00	0.0
4 0-10-20, Bulk	0.0	0.0	0.0	6.55	0.0	16.00	202.00	5.00	0.0
5 Dry Fert Spread	0.0	0.0	0.0	5.50	0.0	7.00	230.00	3.00	0.0
6 Lime, Applied	0.0	0.53	0.0	25.00	0.0	5.00	229.00	3.00	0.0
7 Pre-Emerg Herb	0.0	0.0	0.0	17.02	0.0	7.00	252.00	3.00	0.0
8 Post Emerge Herb	0.0	0.0	0.0	14.76	0.0	7.00	256.00	3.00	0.0
9 Nematicide	0.0	0.0	0.0	32.05	0.0	7.00	206.00	3.00	0.0
10 Insecticide-----	0.0	0.0	0.0	5.47	0.0	7.00	240.00	3.00	0.0
11 Insecticide AP	0.0	0.0	0.0	4.50	0.0	7.00	269.00	3.00	0.0

Monthly Summary of Receipts and Expenses

CATEGORY	UNIT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Total Receipts	Acre	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	204.75	0.0	204.75
Total Expenses	Acre	0.0	0.0	0.0	28.65	68.44	17.74	0.0	7.97	0.0	0.0	14.69	0.0	137.49
Returns to Land, Labor, Capital, Machinery, Overhead, Risk, and Management														67.26
ANNUAL CAPITAL	Dol.	0.0	0.0	0.0	18.72	32.22	7.39	0.0	1.99	0.0	0.0	0.0	0.0	60.32

Labor Requirements by Month

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
MACHINERY LABOR	Hr	0.0	0.0	0.0	0.46	0.84	0.38	0.0	0.0	0.0	0.0	0.62	0.0	2.30

Machinery Fixed and Variable Costs Per Hour

MACHINE	CODE	DEPR	INSUR	TAX	TOTAL FIXED	REPAIR	FUEL	LUB	TOTAL VARIABLE	INT	HR/TIME
Tractor (8)	6	3.72	0.50	0.17	4.38	2.46	4.72	0.71	7.89	5.18	1.00
Pickup Truck	17	2.42	0.10	0.06	2.58	1.30	3.44	0.52	5.26	1.80	1.00
Truck	18	4.73	0.24	0.15	5.11	5.30	3.04	0.46	8.79	4.14	1.00
Corn/Bean Combine	21	35.04	2.01	1.17	38.21	7.38	5.28	0.79	15.41	35.11	0.32
Tandem Disc	39	3.87	0.23	0.14	4.25	1.01	0.0	0.0	1.01	4.05	0.17
Chisel Plow	39	2.19	0.13	0.08	2.40	0.25	0.0	0.0	0.25	2.29	0.21
Sect. Harrow	65	0.49	0.03	0.02	0.53	0.12	0.0	0.0	0.12	0.50	0.17
Corn Planter/ATT	46	6.11	0.36	0.23	6.70	4.29	0.0	0.0	4.29	6.38	0.32
Sprayer TM 1106A	70	0.65	0.03	0.02	0.70	0.67	0.0	0.0	0.67	0.57	0.32
Roll Cultivator	65	5.08	0.16	0.11	5.35	0.35	0.0	0.0	0.35	3.20	0.22
Sprayer TM 110 G	71	0.65	0.03	0.02	0.70	0.67	0.0	0.0	0.67	0.57	0.22

OPERATION	ITEM NO.	DATE	TIMES OVER	LABOR HOURS	MACHINE HOURS	FUEL-OIL-LUB. REPAIR PER ACRE	FIXED COSTS PER ACRE
Tandem Disc	6,39	APR	1.00	0.204	0.169	1.63	3.13
Chisel Plow	6,39	APR	1.00	0.254	0.210	1.87	3.14
Tandem Disc	6,39	MAY	1.00	0.204	0.169	1.63	3.13
Sect Harrow	65	MAY	1.00	0.0	0.169	0.02	0.17
Corn Planter/ATT	6,46	MAY	1.00	0.393	0.329	4.21	7.59
Sprayer TM 1106A	70	MAY	1.00	0.0	0.325	0.22	0.41
Truck	18	MAY	0.10	0.120	0.100	0.88	0.92
Pickup Truck	17	MAY	0.10	0.120	0.100	0.53	0.44
Roll Cultivator	6,65	JUN	1.00	0.262	0.217	1.96	3.65
Sprayer TM 110 G	71	JUN	1.00	0.0	0.217	0.14	0.26
Truck	18	JUN	0.10	0.120	0.100	0.88	0.92
Corn/Bean Combine	21	NOV	1.00	0.382	0.318	4.27	23.35
Truck	18	NOV	0.20	0.240	0.200	1.76	1.85
TOTAL				2.299	2.659	20.00	48.96

SOYBEANS. Effect of varying rates of production and prices on net revenue to land, overhead and management

Rate of production	Total cost per acre	Price per bushel		
		$4.95	$5.85	$6.75
25 bu.	$204.70	$ -80.95	$ -58.45	$ -35.95
35 bu.	204.70	-31.45	0.05	31.55
45 bu.	204.70	18.05	58.55	99.05

10.3 Appendix for Section 6.1.3: Fish

Reports relating the effects of altered freshwater flows on estuarine fisheries

Nature of influence	Brief abstract
Estuarine management. Darnell, R. M. 1981.	At present no estuary of our nation is being properly managed, and none has an adequate management structure. Tools of estuarine management include zoning, permitting authority, and lease/purchase. The best goal in estuarine management is the predisturbance state, and to achieve this goal both general and site-specific knowledge are required.
Reduced freshwater flows. Stegman, J. L. 1981.	For several years Region 2 (US FWS) has identified the problem of reduced freshwater inflow to Texas estuaries as the number one regional environmental problem.
Striped bass declines and reduced freshwater flows. Rote, J. R. and K. Roberts. 1981.	Striped bass populations in the San Francisco Bay estuary have declined 60 to 80 percent. A major factor responsible for the reductions has been reductions in freshwater inflow. In Chesapeake Bay, as well as the east coast estuaries, stocks of striped bass have declined so dramatically that Congress has approved and authorized funding of special studies to determine the cause. Banning the commercial harvest of shad is being considered in Chesapeake Bay, since the catch has declined more than 80 percent since 1970 (i.e. from 5,150,000 to 994,000 pounds). About 3 billion pounds of recent annual U.S. commercial fish landings 60 to 70 percent of the most valuable commercial species of the Atlantic and Gulf Coast - occupy estuaries during all or part of their life cycles. Oyster beds are now being lost from intrusion of oyster predators and parasites upstream in the bay. With additional freshwater diversion this problem could become a major affliction.

Nature of influence	Brief abstract
Salinity variations. Robinson, A. E., Jr. 1981.	Spatial and temporal salinity variations constitute the most significant physical parameter influencing the circulation dynamics of the estuary and the types of aquatic species which reside in it.
Alterations of freshwater inflows. Armstrong, N. E. and G. H. Ward, Jr. 1981.	While the exact mechanisms producing reductions of commercial harvests are being debated, salinity levels and nutrient influxes are considered to be the most important variables.
Adverse impacts of altered freshwater flows. Spear, M. 1981.	Florida Bay has developed into a hypersaline area. It has essentially ceased to function as an estuary. There has been a catastrophic reduction in nursery habitat for estuarine finfish and shellfish due to altered flows of freshwater and reduction of overland flow from 8 months to 4 months. Discharges of fresh water from canals into estuaries are often confined to short time periods and the sudden surges result in fish and shellfish mortalities in estuaries. The catch per shrimp boat has decreased from 44,000 pounds in 1945 to less than 5,000 pounds in 1972. The production per acre of oysters has decreased from 500 pounds in 1945 to about 75 pounds in 1972. The changes are attributed to drainage and saltwater intrusion.
High salinity and white shrimp and oysters. Parker, R. H. 1955.	High salinity has an adverse effect on white shrimp and oysters. Hypersalinity caused by low freshwater inflows resulted in decline to white shrimp and oysters. Mission-Aransas and Nueces, Tex.
Reduced flows. Cooper, D. C. and B. J. Copeland. 1973.	Reduced flows and/or additional effluents would result in negative impacts to estuarine productivity. Trinity-San Jaanto, Texas.
Freshwater inflow is important to Texas shrimp industry. Rayburn, R. 1981.	There is a need for balanced salinity regimes as well as sufficient nutrients and sediments to maintain a sound habitat for shrimp.

Nature of influence	Brief abstract
Optimum salinity for oysters. Breithaupt, R. L. and R. J. Dugas. 1979.	Optimum salinity for oyster was in the 10-15 ppt range. Oyster larvae were killed below 10 ppt and oyster drill doesn't tolerate less than 15 ppt.
Oyster as indicator of optimum salinity range. Lindall, W. M. et al. 1972.	The authors considered oyster a good indicator species for the determination of the optimum salinity range for Louisiana estuarine fisheries in general.
Shrimp production as related to ratio of marshwater interface to area of water. Faller, K. M. 1979.	Local shrimp production is related to the ratio of marshwater interface to area of water. La.
Marsh-salinity correlated with brown shrimp production. Barrett, B. B. and M. S. Gillespie. 1973.	Annual production of brown shrimp was correlated with the acreage of marsh having waters above 10 ppt. salinity. La.
Shrimp and blue crab production as related to low summer salinities. White, C. J. et al. 1969.	Low summer salinities are not suitable for brown and white shrimp but are ideal for blue crabs. Sabine-Neches estuary, TX.
Altered temporal flows affect shrimp harvests. Browder, J. A. and D. Moore. 1981.	Correlation-regression analysis indicated that offshore shrimp catches (brown, white and pink) are positively correlated with spring (April-June) inflow and negatively correlated with winter (January-March) and summer (July-August) inflows. Laguna Madre, Texas.

Nature of influence	Brief abstract
Increased flow of freshwater and nutrient input. Viosca, P. 1938, Gunter, G., 1950, Dugas, R. J., 1977.	Increased oyster and shrimp production was associated with increased freshwater inflows. La.
Detritus. Livingston, R. J. 1981.	Significance of river-derived particulate organic matter to estuarine biota remains in doubt. Fla.
Low flows in wet season affects abundances. Fraser, T. H. 1981.	Extremely dry, wet seasons are accompanied by increased abundance of common and scarce forms. Abundances in such a season affects abundance in the following dry season.
Freshwater discharge and creel results. Van Os, E., et al. 1981.	Freshwater discharges by the St. Lucie Canal, Florida, had significant short-term effects on catch rates of nine important estuarine species and caused their habits to be less predictable.
Salinity and estuarine fauna. Hoese, H. D. 1981.	Normal oligohaline fauna was replaced by freshwater fauna during flood conditions when salinity fell under about 0.5 ppt. Atchafalaya Bay, LA.
Freshwater inputs related to catch of commercial species. Nixon, S. W. 1981.	Did not conclude there was a clear relationship between freshwater flows and yields (except that shrimp catch may be negatively related to freshwater flows.
Altered timing of freshwater flows and reduced catches of shrimp. White, C. J. and W. S. Perret. 1973.	Reduction in catches of brown and white shrimp were associated with reduced inflow surge delayed until mid May due to operation of a dam; Sabine Lake, LA.
Standing stocks and freshwater estuaries. Browder, J. A. and D. Moore. 1981.	Summary of many numerous Gulf States studies indicate highest marine standing stocks are in or near estuaries which receive freshwater inputs.

Nature of influence	Brief abstract
Increased wet season and decreased dry season freshwater inputs in Florida. Browder, J. 1977.	Negative impacts were noted due to seasonal alterations of freshwater inflows.
Increased freshwater flows caused stratification. Van de Kreeke 1979, Yokel, 1979, and Hicks 1979.	Stratification caused low dissolved oxygen in canals during period of high discharge. Benthic life was negatively affected and pelagic fishes were excluded from the area. Lack of mixing in dead-end canals tended to trap and concentrate organic materials including pathogenic bacteria. Fla.
River flow rates control survival of major species. Herrgesell, P. L. et al. 1981.	Annual abundance indices increase directly with river flow rates. (striped bass, chinook, salmon, American shad, longfin smelt). Sacramento-San Joaquin Estuary.
Additional inflow at appropriate time increased survival. Kjelson, M. A. et al. 1981.	Preliminary results indicated that additional inflow at the appropriate time will increase numbers of fry and juvenile salmon using the Sacramento-San Joaquin Estuary.
Rainfall rates and estuarine fish and crustacea. Johnson, D. R. et al. 1981.	Wetter years favored populations of young migratory fishes and crustacea; larger predator fishes tended to be more abundant during dry years than during wet years.
High concentrations of nutrients at time of low flow. Correll, D. L. 1981.	Estuarine receiving waters are commonly threatened by pollution and the impacts are often most pronounced at times of low flow in warm weather.

Nature of influence	Brief abstract
Declining zooplankton populations due to freshwater intrusion. Matthews, G. A. 1981.	Flood waters reduced estuarine zooplankton by 2/3 and sharply reduced salinities of San Antonio Bay. Implication that larval stages of economically important species were adversely affected by the natural phenomenon.
Reduced estuarine zooplankton and major freshwater incursions. Kalke, R. D.	Estuarine zooplankton were flushed out by freshwaters and replaced by freshwater species. Following the freshwater incursion *Acartia tonsa* were successful at salinities of 1 to 3 ppt. This was attributed to the influx of nutrients, food and a decrease of higher salinity predators. Nueces-Corpus Christi and Copano-Aransas Bay systems, TX.
Increased benthos following flood waters. Flint, R. W. and S. C. Rabalais. 1981.	Fresh water, due to flooding, in Corpus Christi Bay, TX., may have introduced nutrient materials thus increasing faunal densities which may be a link to shrimp populations which derive much of their nutrition from benthos.
Detritus and river flow. Copeland, B. J. 1966.	Detritus is a principle element in the food web of estuarine ecosystems.
Nutritional particulate matter and entrapment zone. Barclay, W. R. and A. W. Knight. 1981.	Highest concentrations, of the biochemical components analyzed, occurred in the entrapment zone at salinities of 4 to 6 ppt. San Francisco Bay-Estuary.
Sediment -- assets or liability. van Beek, J. L. and K. Meyer-Arendt. 1981.	Sediments are assets relative to delta building and associated estuarine wetlands, but are liabilities to maintaining navigation.

Nature of influence	Brief abstract
Retention of freshwater on land advantageous for management of estuary. Simpson, B. 1979.	Holding freshwater will decrease total water going to bay (evapotranspiration), increase ratio of delayed runoff to immediate runoff, reduce peak flows, increase base flows, raise dry-season water table, reduce forest fires, prevent saltwater intrusion, increase irrigation water supplies and increase the productivity of wetlands. Fla.
Forestry practices and periods of high runoff from swamps. Livingston, R. J. and J. L. Duncan. 1979.	Forestry operations led to increased amplitudes and decreased duration of runoff events, causing more abrupt than normal changes in salinity and nutrients in the vicinity. Increased water color, decreased dissolved oxygen, decreased pH coincided with periods upper bays were heavily utilized as nursery grounds by fish and invertebrates resulting in significant reduction of white shrimp. Regrowth of covering vegetation had ameliorating effect. Fla.
Climatic variables and production of striped bass. Mihursky, J. A. et al. 1981.	Recruitment of striped bass is determined by the end of the larval stage and their position in the estuary. Where spawning takes place and zooplankton abundance are important factors regulating this process. These factors are in turn influenced by several climatic variables. Several authors have related internal ecosystems characteristic(s) to the behavior of extrinsic variables (Menzel et al. 1966, Aleem 1972). Copeland (1966) found that fishery yields in some Texas bays increase in years of above average river flow. Menzel et al. (1966) showed similar trends for oyster stocks in Apalachicola Bay, Florida. Heinle et al. (1975) concluded that colder than normal winters enhance zooplankton and juvenile fish recruitment in the Patuxent River, Maryland. Sutcliffe et al. (1976) and Sutcliffe et al. (1977) demonstrated significant correlations between catches of 17 species of commercial marine fish and shellfish and sea temperatures in the Gulf of Maine.

Nature of influence	Brief abstract
Altered freshwater flows. Jones, R. A. and T. M. Sholar. 1981.	Unaltered areas had significantly higher production of brown shrimp as well as other commercially important species. Rapidly pulsating events occurred in the altered sites.
Ditching systems and rates of freshwater discharge. Pate, P. P., Jr. and R. Jones. 1981.	Ditching systems are designed to efficiently remove surface waters from cultivated fields, thus increasing peak runoff rates and alters the ability of the inland areas and associated vegetation to act as a natural regulator of surface runoff. The results are an increase in the rate of runoff during and following storms and an unstable salinity pattern responding quickly and dramatically to rainfall. Unaltered shrimp nursery areas were much more stable than were altered areas during the same rain periods. Extensive drainage into a nursery area reduces its value by reducing average salinities and making it more sensitive to the effects of rainfall within the drainage basin. Relative productivity of estuarine organisms was down each year in the nursery area with extensive drainage. The most serious effects of drainage into nursery areas appears to be the degree of alteration and the danger that alteration will be severe enough to create an unsuitable habitat during periods of normal rainfall. N. C.

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10.4 Appendix for Section 6.1.4: Wildlife

Wildlife Habitat Simulation

Introduction

A wildlife habitat quality prediction model forecasts future habitat conditions (given a set of present conditions and a management scheme) so that impacts of proposed management plans may be evaluated.

In 1973, the U. S. Fish and Wildlife Service began developing uniform Habitat Evaluation Procedures (HEP) to assist this process. HEP use simple mathematical functions wich describe habitat quality for particular species, ascribe a quality value to each habitat type in the project area, and sum the quantities (area x value) to obtain an index of habitat quality for a given species on the total area (Adams et al., 1982).

The model presented here uses the HEP concept to predict habitat quality for the three scenarios and four areas considered. The model uses a computer program which operates on an Apple II microcomputer, prompts the user for data input, permits input file editing, provides hard copy printouts of input and output on request, computes land use-habitat type inventories for the end of the project period (with and without the project, by major user), accrues annualized habitat quality units (by species, with and without the project, by major user), and provides an index of overall wildlife habitat impact. Specifically:

1. It requires the following input:

    a. Project duration (20 years in our case).

    b. Land inventory, for each area considered (up to 4 areas) by land use-habitat type (up to 16 types are permitted).

    c. Indicator species (up to 14 species are permitted).

    d. A Habitat Suitability Index (HSI) for each species for each land use-habitat type.

    e. A conversion rate for each land use-habitat type to every other type, based on "PRO", the proportion of the area or absolute area affected, "BEG" and "END", the beginning and end of the period over which the change occurs, and "REG", the form of the regression.

2. It computes annual land use-habitat type conversions as "changes" from one type to another, in accordance with the following user-specified functions.

a. A linear function:

change = (area of type at beginning of the project period x percent of area affected) / period over which change occurs

b. An exponential function:

change = (area of type at beginning of computational year x percent of area affected) / period over which change occurs

c. A time-phased function (5-year increments):

change = (area at end of increment - area at beginning of increment) / 5

d. A fixed increment function:

change = the user-specified increment

e. A sinusoidal function:

change = an annual increment along a partial sine wave encompassing the percent of area affected, over the period in which the change occurs, based on the area of the type at beginning of the project period

For each year, the program computes "change" from each type to every other type, subtracts the "change" from the former, adds it to the latter, computes a new inventory for the beginning of the next year, and accumulates annualized habitat quality units for each species in each habitat.

3. It provides the following outputs:

a. All input data.

b. Habitat conditions (acreage of each type) at the end of the project period, with and without the project for each major user.

c. Accrued annualized habitat quality units for each species, with and without the project, for each major user's land.

d. Total accrued annualized habitat quality units for the project area, with and without the project, and an index of project impact.

e. Average HSI for each species is each area, at the beginning and end of the project.

FUNCTIONS

Functional Entries

Type	Pro.	BEG., END	Req.
Linear	Percent of initial area affected	Period over which change occurs	L
Exponential	Percent of annual inventory affected	Period over which change occurs	E
Sinusoidal	Percent of initial area affected	Period over which change occurs	S
Fixed	Area lost per year	Period over which change occurs	F
Time-phased	Any number > 0	Any number	T
	(Enter accrued area lost at year indicated)		

Variables

PR = project period
PER = period over which change occurs
A = initial area (acres)
AC = area at beginning of given year (annual inventory)
I = land use-habitat type losing area
NUM = land use-habitat type gaining area
P = "Pro." from entry data
Y = "Yr." from entry data
YR = year being computed
Z = area concerned
T5 = accrued area lost by year 5
T10 = accrued area lost by year 10
T15 = accrued area lost by year 15
T20 = accrued area lost by year 20

Equations (solved annually over the period in which change occurs)

```
Linear (L)         Change = (A(I,Z) * (P(I,NUM) / 100)) /
                            PER

Exponential (E)    Change = (AC(I) * (P(I,NUM) / 100)) /
                            PER

Sinusoidal (S)     S1     = (COS(3.1416 * (YR / PER)))
                            + 1
                   S2     = (COS(3.1416 * ((YR-1) / PER)))
                            + 1
                   DI     = (P(I,NUM) / 100) * (A(I,Z) / 2)
                   C1     = S1 * DI
                   C2     = S2 * DI
                   Change = C2 - C1

Fixed (F)          Change = P(I,NUM)
```

```
Time-phased (T)   If YR <= PR / 4  then
                  Change = T5(I,NUM) / (PR * .25)

                  If YR > PR / 4 and YR <= PR / 2 then
                  Change = (T10(I,NUM) - T5(I,NUM)) /
                           (PR * .25)

                  If YR > PR / 2 and YR <= PR / 1.3333
                  then
                  Change = (T15(I,NUM) - T10(I,NUM)) /
                           (PR * .25)

                  If YR > PR / 1.3333 and YR <= PR then
                  Change = (T20(I,NUM) - T15(I,NUM)) /
                           (PR * .25)
```

Inputs to and outputs from the simulation are given on the following pages.

HABITAT TYPES WITHIN PROJECT AREA

1 RESIDENTIAL DEVELOPMENT
2 ROADS AND RIGHTS-OF-WAY
3 OTHER DEVELOPED AREAS
4 AGRICULTURAL LAND
5 DECIDUOUS FOREST
6 EVERGREEN FOREST
7 MIXED FOREST
8 WHITE CEDAR SWAMP
9 MIXED SWAMP
10 DISTURBED LAND
11 HIGH POCOSIN
12 LOW POCOSIN
13 BAY FOREST
14 WATER AND MARSH
15 ACTIVE PEAT MINE
16 INACTIVE PEAT MINE

EVALUATION SPECIES

1 BLACK BEAR
2 WHITETAIL DEER
3 MARSH RABBIT
4 MUSKRAT
5 BOBWHITE
6 MOURNING DOVE
7 GREAT HORNED OWL
8 PINE WARBLER
9 HAIRY WOODPECKER
10 BOBCAT

HABITAT SUITABILITY INDICES FOR BLACK BEAR IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	0
ROADS AND RIGHTS-OF-WAY	.03
OTHER DEVELOPED AREAS	.03
AGRICULTURAL LAND	.24
DECIDUOUS FOREST	.72
EVERGREEN FOREST	.4
MIXED FOREST	.62
WHITE CEDAR SWAMP	.6
MIXED SWAMP	.77
DISTURBED LAND	.47
HIGH POCOSIN	.78
LOW POCOSIN	.73
BAY FOREST	.7
WATER AND MARSH	.23
ACTIVE PEAT MINE	.07
INACTIVE PEAT MINE	.13

HABITAT SUITABILITY INDICES FOR WHITETAIL DEER IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	.02
ROADS AND RIGHTS-OF-WAY	.22
OTHER DEVELOPED AREAS	.08
AGRICULTURAL LAND	.53
DECIDUOUS FOREST	.85
EVERGREEN FOREST	.47
MIXED FOREST	.77
WHITE CEDAR SWAMP	.38
MIXED SWAMP	.58
DISTURBED LAND	.73
HIGH POCOSIN	.6
LOW POCOSIN	.52
BAY FOREST	.57
WATER AND MARSH	.23
ACTIVE PEAT MINE	.1
INACTIVE PEAT MINE	.28

HABITAT SUITABILITY INDICES FOR
MARSH RABBIT IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	.02
ROADS AND RIGHTS-OF-WAY	.2
OTHER DEVELOPED AREAS	.06
AGRICULTURAL LAND	.18
DECIDUOUS FOREST	.32
EVERGREEN FOREST	.24
MIXED FOREST	.24
WHITE CEDAR SWAMP	.42
MIXED SWAMP	.7
DISTURBED LAND	.4
HIGH POCOSIN	.54
LOW POCOSIN	.66
BAY FOREST	.5
WATER AND MARSH	.7
ACTIVE PEAT MINE	.06
INACTIVE PEAT MINE	.22

HABITAT SUITABILITY INDICES FOR
MUSKRAT IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	.05
ROADS AND RIGHTS-OF-WAY	.13
OTHER DEVELOPED AREAS	.12
AGRICULTURAL LAND	.38
DECIDUOUS FOREST	.12
EVERGREEN FOREST	.03
MIXED FOREST	.05
WHITE CEDAR SWAMP	.08
MIXED SWAMP	.27
DISTURBED LAND	.15
HIGH POCOSIN	.08
LOW POCOSIN	.13
BAY FOREST	.05
WATER AND MARSH	.9
ACTIVE PEAT MINE	.05
INACTIVE PEAT MINE	.12

HABITAT SUITABILITY INDICES FOR
BOBWHITE IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	.11
ROADS AND RIGHTS-OF-WAY	.37
OTHER DEVELOPED AREAS	.18
AGRICULTURAL LAND	.75
DECIDUOUS FOREST	.36
EVERGREEN FOREST	.43
MIXED FOREST	.39
WHITE CEDAR SWAMP	.1
MIXED SWAMP	.15
DISTURBED LAND	.7
HIGH POCOSIN	.36
LOW POCOSIN	.32
BAY FOREST	.21
WATER AND MARSH	.12
ACTIVE PEAT MINE	.07
INACTIVE PEAT MINE	.28

HABITAT SUITABILITY INDICES FOR
MOURNING DOVE IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	.3
ROADS AND RIGHTS-OF-WAY	.43
OTHER DEVELOPED AREAS	.28
AGRICULTURAL LAND	.85
DECIDUOUS FOREST	.16
EVERGREEN FOREST	.48
MIXED FOREST	.38
WHITE CEDAR SWAMP	.12
MIXED SWAMP	.12
DISTURBED LAND	.53
HIGH POCOSIN	.15
LOW POCOSIN	.12
BAY FOREST	.1
WATER AND MARSH	.03
ACTIVE PEAT MINE	.07
INACTIVE PEAT MINE	.26

HABITAT SUITABILITY INDICES FOR GREAT HORNED OWL IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	.03
ROADS AND RIGHTS-OF-WAY	.23
OTHER DEVELOPED AREAS	.07
AGRICULTURAL LAND	.4
DECIDUOUS FOREST	.8
EVERGREEN FOREST	.55
MIXED FOREST	.82
WHITE CEDAR SWAMP	.33
MIXED SWAMP	.77
DISTURBED LAND	.59
HIGH POCOSIN	.38
LOW POCOSIN	.33
BAY FOREST	.45
WATER AND MARSH	.15
ACTIVE PEAT MINE	.05
INACTIVE PEAT MINE	.23

HABITAT SUITABILITY INDICES FOR PINE WARBLER IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	.05
ROADS AND RIGHTS-OF-WAY	.08
OTHER DEVELOPED AREAS	.08
AGRICULTURAL LAND	.08
DECIDUOUS FOREST	.2
EVERGREEN FOREST	.96
MIXED FOREST	.64
WHITE CEDAR SWAMP	.33
MIXED SWAMP	.34
DISTURBED LAND	.1
HIGH POCOSIN	.5
LOW POCOSIN	.34
BAY FOREST	.26
WATER AND MARSH	0
ACTIVE PEAT MINE	0
INACTIVE PEAT MINE	.06

HABITAT SUITABILITY INDICES FOR HAIRY WOODPECKER IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	.13
ROADS AND RIGHTS-OF-WAY	.06
OTHER DEVELOPED AREAS	.1
AGRICULTURAL LAND	.04
DECIDUOUS FOREST	.8
EVERGREEN FOREST	.66
MIXED FOREST	.84
WHITE CEDAR SWAMP	.5
MIXED SWAMP	.56
DISTURBED LAND	.16
HIGH POCOSIN	.52
LOW POCOSIN	.36
BAY FOREST	.42
WATER AND MARSH	0
ACTIVE PEAT MINE	0
INACTIVE PEAT MINE	.06

HABITAT SUITABILITY INDICES FOR BOBCAT IN:

TYPE	HSI
RESIDENTIAL DEVELOPMENT	.02
ROADS AND RIGHTS-OF-WAY	.15
OTHER DEVELOPED AREAS	.05
AGRICULTURAL LAND	.28
DECIDUOUS FOREST	.68
EVERGREEN FOREST	.53
MIXED FOREST	.75
WHITE CEDAR SWAMP	.56
MIXED SWAMP	.7
DISTURBED LAND	.65
HIGH POCOSIN	.67
LOW POCOSIN	.65
BAY FOREST	.62
WATER AND MARSH	.25
ACTIVE PEAT MINE	.03
INACTIVE PEAT MINE	.22

```
RATE OF HABITAT CONVERSION IN
AREA 1,SCENARIO #1,
WITHOUT THE PROJECT.

FROM DISTURBED LAND       TO:

         TYPE             PRO BEG END R

HIGH POCOSIN              3.5 1   20  E
LOW POCOSIN               16.51   20  E
BAY FOREST                0   0   0
WATER AND MARSH           0   0   0
ACTIVE PEAT MINE          0   0   0
INACTIVE PEAT MINE        0   0   0
RESIDENTIAL DEVELOPMENT   0   0   0
ROADS AND RIGHTS-OF-WAY   0   0   0
OTHER DEVELOPED AREAS     0   0   0
AGRICULTURAL LAND         0   0   0
DECIDUOUS FOREST          0   0   0
EVERGREEN FOREST          0   0   0
MIXED FOREST              0   0   0
WHITE CEDAR SWAMP         0   0   0
MIXED SWAMP               0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1,SCENARIO #1,
WITHOUT THE PROJECT.

FROM INACTIVE PEAT MINE TO:

         TYPE             PRO BEG END F

RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS   0   0   0
AGRICULTURAL LAND       0   0   0
DECIDUOUS FOREST        0   0   0
EVERGREEN FOREST        0   0   0
MIXED FOREST            0   0   0
WHITE CEDAR SWAMP       0   0   0
MIXED SWAMP             0   0   0
DISTURBED LAND          0   0   0
HIGH POCOSIN            0   0   0
LOW POCOSIN             0   0   0
BAY FOREST              0   0   0
WATER AND MARSH         100 5   20  T
BY YEAR
5 = 0      10 = 316  15 = 316  20 = 31
ACTIVE PEAT MINE        0   0   0
```

```
HABITAT CONDITIONS,SCENARIO #1.
AT THE END OF THE PROJECT PERIOD.
AREA 1 WITHOUT THE PROJECT.

     TYPE                     ACRES

RESIDENTIAL DEVELOPMENT       0
ROADS AND RIGHTS-OF-WAY       0
OTHER DEVELOPED AREAS         0
AGRICULTURAL LAND             2849
DECIDUOUS FOREST              0
EVERGREEN FOREST              0
MIXED FOREST                  0
WHITE CEDAR SWAMP             0
MIXED SWAMP                   0
DISTURBED LAND                100
HIGH POCOSIN                  2138
LOW POCOSIN                   10100
BAY FOREST                    0
WATER AND MARSH               632
ACTIVE PEAT MINE              0
INACTIVE PEAT MINE            0

          TOTAL               15819
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1,SCENARIO #1,
WITHOUT THE PROJECT.

TYPE                   SPEC.
    1      2      3      4      5

1   0      0      0      0      0
2   0      0      0      0      0
3   0      0      0      0      0
4   684    1509   513    1082   2136
5   0      0      0      0      0
6   0      0      0      0      0
7   0      0      0      0      0
8   0      0      0      0      0
9   0      0      0      0      0
10  808    1256   688    258    1204
11  1447   1113   1001   148    668
12  6397   4557   5784   1139   2804
13  0      0      0      0      0
14  120    120    365    469    63
15  0      0      0      0      0
16  14     31     24     13     31

T   9470   8586   8375   3110   6905
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA .SCENARIO #1,
WITHOUT THE PROJECT.  (CONTINUED)

TYPE                   SPEC.             TOT.
    6      7      8      9      10

1   0      0      0      0      0      0
2   0      0      0      0      0      0
3   0      0      0      0      0      0
4   2421   1139   228    114    797    1062
5   0      0      0      0      0      0
6   0      0      0      0      0      0
7   0      0      0      0      0      0
8   0      0      0      0      0      0
9   0      0      0      0      0      0
10  912    998    172    275    1118   7688
11  278    705    927    964    1243   8494
12  1052   2892   2980   3155   5696   3645
13  0      0      0      0      0      0
14  16     78     0      0      130    1361
15  0      0      0      0      0      0
16  29     25     7      7      24     206

T   4707   5837   4313   4515   9009   64828
```

```
RATE OF HABITAT CONVERSION IN
AREA 1,SCENARIO #1,
WITH THE PROJECT.

FROM AGRICULTURAL LAND TO:

          TYPE               PRO BEG END R

DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
LOW POCOSIN                  0   0   0
BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
ACTIVE PEAT MINE             102 1   20  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #1,
WITH THE PROJECT.

FROM DISTURBED LAND          TO:

          TYPE               PRO BEG END R

HIGH POCOSIN                 0   1   0
LOW POCOSIN                  0   1   0
BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
ACTIVE PEAT MINE             313 1   20  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #1.
WITH THE PROJECT.

FROM HIGH POCOSIN TO:

        TYPE                PRO BEG END R

LOW POCOSIN                 0   0   0
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
ACTIVE PEAT MINE            23  1   20  F
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS   0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #1.
WITH THE PROJECT.

FROM LOW POCOSIN TO:

        TYPE                PRO BEG END F

BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
ACTIVE PEAT MINE            108 1   20  F
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS   0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              0   0   0
HIGH POCOSIN                0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1 ,SCENARIO #1.
WITH THE PROJECT.

FROM WATER AND MARSH TO:

        TYPE                PRO BEG END R

ACTIVE PEAT MINE            11  1   20  F
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS   0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              0   0   0
HIGH POCOSIN                0   0   0
LOW POCOSIN                 0   0   0
BAY FOREST                  0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1 ,SCENARIO #1.
WITH THE PROJECT.

FROM ACTIVE PEAT MINE TO:

        TYPE                PRO BEG END R

INACTIVE PEAT MINE          100 2   20  T
BY YEAR
5 = 2840  10 = 5680 15 = 8520 20 = 11360
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS   0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              0   0   0
HIGH POCOSIN                0   0   0
LOW POCOSIN                 0   0   0
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #1.
WITH THE PROJECT.

FROM INACTIVE PEAT MINE TO:

         TYPE              PRO BEG END R

RESIDENTIAL DEVELOPMENT 0    0    0
ROADS AND RIGHTS-OF-WAY 0    0    0
OTHER DEVELOPED AREAS   0    0    0
AGRICULTURAL LAND       70   5    20   T
BY YEAR
5 = 0      10 = 102  15 = 2555 20 = 4948
DECIDUOUS FOREST        0    0    0
EVERGREEN FOREST        70   5    20   T
BY YEAR
5 = 0      10 = 202  15 = 500  20 = 798
MIXED FOREST            0    0    0
WHITE CEDAR SWAMP       0    0    0
MIXED SWAMP             0    0    0
DISTURBED LAND          0    0    0
HIGH POCOSIN            70   5    20   T
BY YEAR
5 = 0      10 = 35   15 = 87   20 = 139
LOW POCOSIN             70   5    20   T
BY YEAR
5 = 0      10 = 167  15 = 413  20 = 659
BAY FOREST              0    0    0
WATER AND MARSH         70   3    20   T
BY YEAR
5 = 909    10 = 1817 15 = 1817 20 = 1817
ACTIVE PEAT MINE        11   1    20   F
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1.SCENARIO #1.
WITH THE PROJECT.

TYPE                SPEC.
   1      2      3      4      5

1  0      0      0      0      0
2  0      0      0      0      0
3  0      0      0      0      0
4  764    1687   573    1210   2388
5  0      0      0      0      0
6  118    139    71     9      127
7  0      0      0      0      0
8  0      0      0      0      0
9  0      0      0      0      0
10 2544   3952   2165   812    3789
11 345    266    239    35     159
12 1544   1100   1396   275    677
13 0      0      0      0      0
14 288    288    873    1129   151
15 40     57     34     28     40
16 331    713    560    306    713

T  5975   8201   5916   3804   8043
```

```
HABITAT CONDITIONS.SCENARIO #1.
AT THE END OF THE PROJECT PERIOD.
AREA 1 WITH THE PROJECT.

     TYPE                     ACRES

RESIDENTIAL DEVELOPMENT       0
ROADS AND RIGHTS-OF-WAY       0
OTHER DEVELOPED AREAS         0
AGRICULTURAL LAND             5756
DECIDUOUS FOREST              0
EVERGREEN FOREST              798
MIXED FOREST                  0
WHITE CEDAR SWAMP             0
MIXED SWAMP                   0
DISTURBED LAND                2440
HIGH POCOSIN                  312
LOW POCOSIN                   1504
BAY FOREST                    0
WATER AND MARSH               1549
ACTIVE PEAT MINE              568
INACTIVE PEAT MINE            2891

              TOTAL           15818
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1.SCENARIO #1.
WITH THE PROJECT.      (CONTINUED)

TYPE                SPEC.               TOT.
   6      7      8      9      10

1  0      0      0      0      0      0
2  0      0      0      0      0      0
3  0      0      0      0      0      0
4  2706   1273   255    127    891    11874
5  0      0      0      0      0      0
6  142    162    283    195    156    1402
7  0      0      0      0      0      0
8  0      0      0      0      0      0
9  0      0      0      0      0      0
10 2869   3140   541    866    3519   24198
11 66     168    221    230    297    2028
12 254    698    719    761    1375   8798
13 0      0      0      0      0      0
14 38     188    0      0      314    3274
15 40     28     0      0      17     284
16 662    586    153    153    560    4735

T  6776   6244   2173   2333   7129   56594
```

```
RATE OF HABITAT CONVERSION IN
AREA 2.SCENARIO #1,
WITHOUT THE PROJECT.

FROM EVERGREEN FOREST TO:

          TYPE              PRO BEG END R

MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              3.3 1   30  E
HIGH POCOSIN                0   0   0
LOW POCOSIN                 0   0   0
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
ACTIVE PEAT MINE            0   0   0
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2.SCENARIO #1,
WITHOUT THE PROJECT.

FROM MIXED SWAMP  TO:

          TYPE              PRO BEG END R

DISTURBED LAND              1.251   30  E
HIGH POCOSIN                0   0   0
LOW POCOSIN                 0   0   0
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
ACTIVE PEAT MINE            0   0   0
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2.SCENARIO #1,
WITHOUT THE PROJECT.

FROM DISTURBED LAND         TO:

          TYPE              PRO BEG END R

HIGH POCOSIN                7.7 1   20  E
LOW POCOSIN                 5.9 1   20  E
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
ACTIVE PEAT MINE            0   1   0
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            5.9 1   20  E
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 .4  1   20  E
```

```
HABITAT CONDITIONS,SCENARIO #1,
AT THE END OF THE PROJECT PERIOD.
AREA 2 WITHOUT THE PROJECT.

        TYPE                       ACRES

RESIDENTIAL DEVELOPMENT            0
ROADS AND RIGHTS-OF-WAY            0
OTHER DEVELOPED AREAS              0
AGRICULTURAL LAND                  1071
DECIDUOUS FOREST                   0
EVERGREEN FOREST                   1147
MIXED FOREST                       0
WHITE CEDAR SWAMP                  0
MIXED SWAMP                        115
DISTURBED LAND                     245
HIGH POCOSIN                       2585
LOW POCOSIN                        1979
BAY FOREST                         0
WATER AND MARSH                    0
ACTIVE PEAT MINE                   0
INACTIVE PEAT MINE                 0

               TOTAL               7142
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2. SCENARIO #1,
WITHOUT THE PROJECT.

TYPE                   SPEC.
    1       2       3       4       5

1   0       0       0       0       0
2   0       0       0       0       0
3   0       0       0       0       0
4   257     568     193     407     803
5   0       0       0       0       0
6   509     598     305     38      547
7   0       0       0       0       0
8   0       0       0       0       0
9   85      64      77      30      17
10  355     552     302     113     529
11  1737    1336    1203    178     802
12  1245    887     1125    222     546
13  0       0       0       0       0
14  0       0       0       0       0
15  0       0       0       0       0
16  0       0       0       0       0

T   4188    4004    3206    988     3244
```

```
RATE OF HABITAT CONVERSION IN
AREA 2. SCENARIO #1.
WITH THE PROJECT.

FROM AGRICULTURAL LAND TO:

          TYPE                PRO BEG END R

DECIDUOUS FOREST              0    0    0
EVERGREEN FOREST              0    0    0
MIXED FOREST                  0    0    0
WHITE CEDAR SWAMP             0    0    0
MIXED SWAMP                   0    0    0
DISTURBED LAND                0    0    0
HIGH POCOSIN                  0    0    0
LOW POCOSIN                   0    0    0
BAY FOREST                    0    0    0
WATER AND MARSH               0    0    0
ACTIVE PEAT MINE              45   1    20   F
INACTIVE PEAT MINE            0    0    0
RESIDENTIAL DEVELOPMENT       0    0    0
ROADS AND RIGHTS-OF-WAY       0    0    0
OTHER DEVELOPED AREAS         0    0    0
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2. SCENARIO #1,
WITHOUT THE PROJECT.  (CONTINUED)

TYPE                   SPEC.              TOT.
    6       7       8       9       10

1   0       0       0       0       0       0
2   0       0       0       0       0       0
3   0       0       0       0       0       0
4   910     428     86      43      300     3995
5   0       0       0       0       0       0
6   611     700     1222    840     674     6045
7   0       0       0       0       0       0
8   0       0       0       0       0       0
9   13      85      37      62      77      547
10  401     438     76      121     491     3379
11  334     846     1114    1158    1492    1020
12  205     563     580     614     1108    7094
13  0       0       0       0       0       0
14  0       0       0       0       0       0
15  0       0       0       0       0       0
16  0       0       0       0       0       0

T   2474    3061    3114    2837    4143    3125
```

```
RATE OF HABITAT CONVERSION IN
AREA 2. SCENARIO #1.
WITH THE PROJECT.

FROM EVERGREEN FOREST TO:

          TYPE                PRO BEG END R

MIXED FOREST                  0    0    0
WHITE CEDAR SWAMP             0    0    0
MIXED SWAMP                   0    0    0
DISTURBED LAND                0    1    0
HIGH POCOSIN                  0    0    0
LOW POCOSIN                   0    0    0
BAY FOREST                    0    0    0
WATER AND MARSH               0    0    0
ACTIVE PEAT MINE              39   1    20   F
INACTIVE PEAT MINE            0    0    0
RESIDENTIAL DEVELOPMENT       0    0    0
ROADS AND RIGHTS-OF-WAY       0    0    0
OTHER DEVELOPED AREAS         0    0    0
AGRICULTURAL LAND             0    0    0
DECIDUOUS FOREST              0    0    0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2, SCENARIO #1,
WITH THE PROJECT.

FROM MIXED SWAMP  TO:

          TYPE                 PRO BEG END R

DISTURBED LAND                 0   1   0
HIGH POCOSIN                   0   0   0
LOW POCOSIN                    0   0   0
BAY FOREST                     0   0   0
WATER AND MARSH                0   0   0
ACTIVE PEAT MINE               3   1   20  F
INACTIVE PEAT MINE             0   0   0
RESIDENTIAL DEVELOPMENT        0   0   0
ROADS AND RIGHTS-OF-WAY        0   0   0
OTHER DEVELOPED AREAS          0   0   0
AGRICULTURAL LAND              0   0   0
DECIDUOUS FOREST               0   0   0
EVERGREEN FOREST               0   0   0
MIXED FOREST                   0   0   0
WHITE CEDAR SWAMP              0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2, SCENARIO #1,
WITH THE PROJECT.

FROM DISTURBED LAND      TO:

          TYPE                 PRO BEG END R

HIGH POCOSIN                   0   1   0
LOW POCOSIN                    0   1   0
BAY FOREST                     0   0   0
WATER AND MARSH                0   0   0
ACTIVE PEAT MINE               123 1   20  F
INACTIVE PEAT MINE             0   0   0
RESIDENTIAL DEVELOPMENT        0   0   0
ROADS AND RIGHTS-OF-WAY        0   0   0
OTHER DEVELOPED AREAS          0   0   0
AGRICULTURAL LAND              0   0   0
DECIDUOUS FOREST               0   0   0
EVERGREEN FOREST               0   1   0
MIXED FOREST                   0   0   0
WHITE CEDAR SWAMP              0   0   0
MIXED SWAMP                    0   1   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2, SCENARIO #1,
WITH THE PROJECT.

FROM HIGH POCOSIN TO:

          TYPE                 PRO BEG END R

LOW POCOSIN                    0   0   0
BAY FOREST                     0   0   0
WATER AND MARSH                0   0   0
ACTIVE PEAT MINE               51  1   20  F
INACTIVE PEAT MINE             0   0   0
RESIDENTIAL DEVELOPMENT        0   0   0
ROADS AND RIGHTS-OF-WAY        0   0   0
OTHER DEVELOPED AREAS          0   0   0
AGRICULTURAL LAND              0   0   0
DECIDUOUS FOREST               0   0   0
EVERGREEN FOREST               0   0   0
MIXED FOREST                   0   0   0
WHITE CEDAR SWAMP              0   0   0
MIXED SWAMP                    0   0   0
DISTURBED LAND                 0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2, SCENARIO #1,
WITH THE PROJECT.

FROM LOW POCOSIN TO:

          TYPE                 PRO BEG END R

BAY FOREST                     0   0   0
WATER AND MARSH                0   0   0
ACTIVE PEAT MINE               39  1   20  F
INACTIVE PEAT MINE             0   0   0
RESIDENTIAL DEVELOPMENT        0   0   0
ROADS AND RIGHTS-OF-WAY        0   0   0
OTHER DEVELOPED AREAS          0   0   0
AGRICULTURAL LAND              0   0   0
DECIDUOUS FOREST               0   0   0
EVERGREEN FOREST               0   0   0
MIXED FOREST                   0   0   0
WHITE CEDAR SWAMP              0   0   0
MIXED SWAMP                    0   0   0
DISTURBED LAND                 0   0   0
HIGH POCOSIN                   0   0   0
```

RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #1.
WITH THE PROJECT.

FROM ACTIVE PEAT MINE TO:

TYPE	PRO	BEG	END	R
INACTIVE PEAT MINE	300	2	20	F
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	0	0	0	
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	0	0	0	
MIXED FOREST	0	0	0	
WHITE CEDAR SWAMP	0	0	0	
MIXED SWAMP	0	0	0	
DISTURBED LAND	0	0	0	
HIGH POCOSIN	0	0	0	
LOW POCOSIN	0	0	0	
BAY FOREST	0	0	0	
WATER AND MARSH	0	0	0	

RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #1.
WITH THE PROJECT.

FROM INACTIVE PEAT MINE TO:

TYPE	PRO	BEG	END	R
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	240	6	20	F
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	30	6	20	F
MIXED FOREST	0	0	0	
WHITE CEDAR SWAMP	0	0	0	
MIXED SWAMP	1	6	20	F
DISTURBED LAND	0	0	0	
HIGH POCOSIN	16.46		20	F
LOW POCOSIN	12.66		20	F
BAY FOREST	0	0	0	
WATER AND MARSH	0	3	0	
ACTIVE PEAT MINE	0	1	0	

HABITAT CONDITIONS, SCENARIO #1,
AT THE END OF THE PROJECT PERIOD.
AREA 2 WITH THE PROJECT.

TYPE	ACRES
RESIDENTIAL DEVELOPMENT	0
ROADS AND RIGHTS-OF-WAY	0
OTHER DEVELOPED AREAS	0
AGRICULTURAL LAND	3771
DECIDUOUS FOREST	0
EVERGREEN FOREST	599
MIXED FOREST	0
WHITE CEDAR SWAMP	0
MIXED SWAMP	26
DISTURBED LAND	468
HIGH POCOSIN	440
LOW POCOSIN	338
BAY FOREST	0
WATER AND MARSH	0
ACTIVE PEAT MINE	300
INACTIVE PEAT MINE	1200
TOTAL	7142

ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2 . SCENARIO #1.
WITH THE PROJECT.

TYPE	SPEC.				
	1	2	3	4	5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	489	1080	367	775	1529
5	0	0	0	0	0
6	280	329	168	21	301
7	0	0	0	0	0
8	0	0	0	0	0
9	35	26	32	12	7
10	769	1195	655	245	1146
11	606	466	420	62	280
12	434	309	393	77	190
13	0	0	0	0	0
14	0	0	0	0	0
15	21	30	18	15	21
16	137	294	231	126	294
T	2771	3730	2283	1334	3767

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2 . SCENARIO #1,
WITH THE PROJECT.      (CONTINUED)

TYPE                    SPEC.           TOT.
    6      7      8      9      10

1   0      0      0      0      0       0
2   0      0      0      0      0       0
3   0      0      0      0      0       0
4   1733   815    163    82     571     7604
5   0      0      0      0      0       0
6   336    385    672    462    371     3323
7   0      0      0      0      0       0
8   0      0      0      0      0       0
9   5      35     15     25     32      226
10  867    949    164    262    1064    7315
11  117    295    388    404    521     3558
12  71     196    202    214    387     2476
13  0      0      0      0      0       0
14  0      0      0      0      0       0
15  21     15     0      0      9       150
16  273    242    63     63     231     1953

T   3423   2932   1668   1512   3184    26604
```

```
RATE OF HABITAT CONVERSION IN
AREA 1,SCENARIO #2,
WITHOUT THE PROJECT.

FROM DISTURBED LAND      TO:

        TYPE             PRO BEG END R

HIGH POCOSIN             4.6 1   20  E
LOW POCOSIN              15.41   20  E
BAY FOREST               0   0   0
WATER AND MARSH          0   0   0
ACTIVE PEAT MINE         0   0   0
INACTIVE PEAT MINE       0   0   0
RESIDENTIAL DEVELOPMENT  0   0   0
ROADS AND RIGHTS-OF-WAY  0   0   0
OTHER DEVELOPED AREAS    0   0   0
AGRICULTURAL LAND        0   0   0
DECIDUOUS FOREST         0   0   0
EVERGREEN FOREST         0   0   0
MIXED FOREST             0   0   0
WHITE CEDAR SWAMP        0   0   0
MIXED SWAMP              0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1,SCENARIO #2,
WITHOUT THE PROJECT.

FROM INACTIVE PEAT MINE TO:

        TYPE             PRO BEG END R

RESIDENTIAL DEVELOPMENT  0   0   0
ROADS AND RIGHTS-OF-WAY  0   0   0
OTHER DEVELOPED AREAS    0   0   0
AGRICULTURAL LAND        0   0   0
DECIDUOUS FOREST         0   0   0
EVERGREEN FOREST         0   0   0
MIXED FOREST             0   0   0
WHITE CEDAR SWAMP        0   0   0
MIXED SWAMP              0   0   0
DISTURBED LAND           0   0   0
HIGH POCOSIN             0   0   0
LOW POCOSIN              0   0   0
BAY FOREST               0   0   0
WATER AND MARSH          100 5   20  T
BY YEAR
5 = 0     10 = 300   15 = 300   20 = 300
ACTIVE PEAT MINE         0   0   0
```

```
HABITAT CONDITIONS,SCENARIO #2,
AT THE END OF THE PROJECT PERIOD.
AREA 1 WITHOUT THE PROJECT.

    TYPE                       ACRES

RESIDENTIAL DEVELOPMENT        0
ROADS AND RIGHTS-OF-WAY        0
OTHER DEVELOPED AREAS          0
AGRICULTURAL LAND              2700
DECIDUOUS FOREST               0
EVERGREEN FOREST               0
MIXED FOREST                   0
WHITE CEDAR SWAMP              0
MIXED SWAMP                    0
DISTURBED LAND                 111
HIGH POCOSIN                   6033
LOW POCOSIN                    20507
BAY FOREST                     0
WATER AND MARSH                600
ACTIVE PEAT MINE               0
INACTIVE PEAT MINE             0

               TOTAL           30000
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1,SCENARIO #2.
WITHOUT THE PROJECT.

TYPE                    SPEC.
    1       2       3       4       5

1   0       0       0       0       0
2   0       0       0       0       0
3   0       0       0       0       0
4   648     1431    486     1026    2025
5   0       0       0       0       0
6   0       0       0       0       0
7   0       0       0       0       0
8   0       0       0       0       0
9   0       0       0       0       0
10  892     1385    759     285     1329
11  4424    3403    3063    454     2042
12  13965   9948    12626   2487    6122
13  0       0       0       0       0
14  114     114     347     446     59
15  0       0       0       0       0
16  14      29      23      13      29

T   20057   16311   17304   4709    11606
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1,SCENARIO #2.
WITHOUT THE PROJECT.  (CONTINUED)

TYPE                    SPEC.               TOT.
    6       7       8       9       10

1   0       0       0       0       0       0
2   0       0       0       0       0       0
3   0       0       0       0       0       0
4   2295    1080    216     108     756     10071
5   0       0       0       0       0       0
6   0       0       0       0       0       0
7   0       0       0       0       0       0
8   0       0       0       0       0       0
9   0       0       0       0       0       0
10  1006    1101    190     304     1234    8483
11  851     2155    2836    2949    3800    25975
12  2296    6313    6504    6887    12435   79583
13  0       0       0       0       0       0
14  15      74      0       0       124     1292
15  0       0       0       0       0       0
16  27      24      6       6       23      195

T   6489    10747   9752    10254   18371   125601
```

```
RATE OF HABITAT CONVERSION IN
AREA 1,SCENARIO #2.
WITH THE PROJECT.

FROM AGRICULTURAL LAND TO:

           TYPE              PRO BEG END R

DECIDUOUS FOREST             0    0   0
EVERGREEN FOREST             0    0   0
MIXED FOREST                 0    0   0
WHITE CEDAR SWAMP            0    0   0
MIXED SWAMP                  0    0   0
DISTURBED LAND               0    0   0
HIGH POCOSIN                 0    0   0
LOW POCOSIN                  0    0   0
BAY FOREST                   0    0   0
WATER AND MARSH              0    0   0
ACTIVE PEAT MINE             135  1   20  F
INACTIVE PEAT MINE           0    0   0
RESIDENTIAL DEVELOPMENT      0    0   0
ROADS AND RIGHTS-OF-WAY      0    0   0
OTHER DEVELOPED AREAS        0    0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1,SCENARIO #2.
WITH THE PROJECT.

FROM DISTURBED LAND      TO:

           TYPE              PRO BEG END R

HIGH POCOSIN                 0    1   0
LOW POCOSIN                  0    1   0
BAY FOREST                   0    0   0
WATER AND MARSH              0    0   0
ACTIVE PEAT MINE             480  1   20  F
INACTIVE PEAT MINE           0    0   0
RESIDENTIAL DEVELOPMENT      0    0   0
ROADS AND RIGHTS-OF-WAY      0    0   0
OTHER DEVELOPED AREAS        0    0   0
AGRICULTURAL LAND            0    0   0
DECIDUOUS FOREST             0    0   0
EVERGREEN FOREST             0    0   0
MIXED FOREST                 0    0   0
WHITE CEDAR SWAMP            0    0   0
MIXED SWAMP                  0    0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #2.
WITH THE PROJECT.

FROM HIGH POCOSIN TO:

          TYPE                 PRO BEG END R

LOW POCOSIN                    0   0   0
BAY FOREST                     0   0   0
WATER AND MARSH                0   0   0
ACTIVE PEAT MINE               195 1   20  F
INACTIVE PEAT MINE             0   0   0
RESIDENTIAL DEVELOPMENT        0   0   0
ROADS AND RIGHTS-OF-WAY        0   0   0
OTHER DEVELOPED AREAS          0   0   0
AGRICULTURAL LAND              0   0   0
DECIDUOUS FOREST               0   0   0
EVERGREEN FOREST               0   0   0
MIXED FOREST                   0   0   0
WHITE CEDAR SWAMP              0   0   0
MIXED SWAMP                    0   0   0
DISTURBED LAND                 0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #2.
WITH THE PROJECT.

FROM LOW POCOSIN TO:

          TYPE                 PRO BEG END R

BAY FOREST                     0   0   0
WATER AND MARSH                0   0   0
ACTIVE PEAT MINE               560 1   20  F
INACTIVE PEAT MINE             0   0   0
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS          0   0   0
AGRICULTURAL LAND              0   0   0
DECIDUOUS FOREST               0   0   0
EVERGREEN FOREST               0   0   0
MIXED FOREST                   0   0   0
WHITE CEDAR SWAMP              0   0   0
MIXED SWAMP                    0   0   0
DISTURBED LAND                 0   0   0
HIGH POCOSIN                   0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #2.
WITH THE PROJECT.

FROM WATER AND MARSH TO:

          TYPE                 PRO BEG END R

ACTIVE PEAT MINE               15  1   20  F
INACTIVE PEAT MINE             0   0   0
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS          0   0   0
AGRICULTURAL LAND              0   0   0
DECIDUOUS FOREST               0   0   0
EVERGREEN FOREST               0   0   0
MIXED FOREST                   0   0   0
WHITE CEDAR SWAMP              0   0   0
MIXED SWAMP                    0   0   0
DISTURBED LAND                 0   0   0
HIGH POCOSIN                   0   0   0
LOW POCOSIN                    0   0   0
BAY FOREST                     0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #2.
WITH THE PROJECT.

FROM ACTIVE PEAT MINE TO:

          TYPE                 PRO BEG END R

INACTIVE PEAT MINE             15002   20  F
RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS          0   0   0
AGRICULTURAL LAND              0   0   0
DECIDUOUS FOREST               0   0   0
EVERGREEN FOREST               0   0   0
MIXED FOREST                   0   0   0
WHITE CEDAR SWAMP              0   0   0
MIXED SWAMP                    0   0   0
DISTURBED LAND                 0   0   0
HIGH POCOSIN                   0   0   0
LOW POCOSIN                    0   0   0
BAY FOREST                     0   0   0
WATER AND MARSH                0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #2,
WITH THE PROJECT.

FROM INACTIVE PEAT MINE TO:

          TYPE               PRO BEG END R

RESIDENTIAL DEVELOPMENT 0    0    0
ROADS AND RIGHTS-OF-WAY 0    0    0
OTHER DEVELOPED AREAS   0    0    0
AGRICULTURAL LAND       56   5    20   T
BY YEAR
5 = 0      10 = 1653 15 = 9213 20 = 16773
DECIDUOUS FOREST        0    0    0
EVERGREEN FOREST        8.2 5     20   T
BY YEAR
5 = 0      10 = 570  15 = 1515 20 = 2460
MIXED FOREST            0    0    0
WHITE CEDAR SWAMP       0    0    0
MIXED SWAMP             0    0    0
DISTURBED LAND          0    0    0
HIGH POCOSIN            1.9 5     20   T
BY YEAR
5 = 0      10 = 130  15 = 345.520 = 561.1
LOW POCOSIN             6.3 5     20   T
BY YEAR
5 = 0      10 = 440  15 = 1169.520 = 1898.9
BAY FOREST              0    0    0
WATER AND MARSH         9.7 5     20   T
BY YEAR
5 = 0      10 = 2907 15 = 2907 20 = 2907
ACTIVE PEAT MINE        15   1    20   F
```

```
HABITAT CONDITIONS.SCENARIO #2,
AT THE END OF THE PROJECT PERIOD.
AREA 1 WITH THE PROJECT.

     TYPE                        ACRES

RESIDENTIAL DEVELOPMENT          0
ROADS AND RIGHTS-OF-WAY          0
OTHER DEVELOPED AREAS            0
AGRICULTURAL LAND                16773
DECIDUOUS FOREST                 0
EVERGREEN FOREST                 2460
MIXED FOREST                     0
WHITE CEDAR SWAMP                0
MIXED SWAMP                      0
DISTURBED LAND                   0
HIGH POCOSIN                     561
LOW POCOSIN                      1899
BAY FOREST                       0
WATER AND MARSH                  2907
ACTIVE PEAT MINE                 1500
INACTIVE PEAT MINE               3900

              TOTAL              30000
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1.SCENARIO #2.
WITH THE PROJECT.

TYPE                SPEC.
   1      2      3      4      5

1  0      0      0      0      0
2  0      0      0      0      0
3  0      0      0      0      0
4  1564   3453   1173   2476   4886
5  0      0      0      0      0
6  356    418    214    27     383
7  0      0      0      0      0
8  0      0      0      0      0
9  0      0      0      0      0
10 2143   3329   1824   684    3192
11 1603   1233   1110   164    740
12 5079   3618   4592   904    2226
13 0      0      0      0      0
14 467    467    1422   1829   244
15 105    150    90     75     105
16 714    1537   1208   659    1537

T  12031  14206  11632  6818   13313
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1.SCENARIO #2.
WITH THE PROJECT.      (CONTINUED)

TYPE                SPEC.               TOT.
   6      7      8      9      10

1  0      0      0      0      0      0
2  0      0      0      0      0      0
3  0      0      0      0      0      0
4  5538   2606   521    261    1824   24301
5  0      0      0      0      0      0
6  427    490    855    588    472    4229
7  0      0      0      0      0      0
8  0      0      0      0      0      0
9  0      0      0      0      0      0
10 2417   2645   456    730    2964   20383
11 308    781    1028   1069   1377   9414
12 835    2296   2365   2505   4522   28942
13 0      0      0      0      0      0
14 61     305    0      0      508    5304
15 105    75     0      0      45     750
16 1427   1263   329    329    1208   10211

T  11118  10460  5554   5481   12920  10353
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 ,SCENARIO #2,
WITHOUT THE PROJECT.

FROM EVERGREEN FOREST TO:

          TYPE                PRO BEG END R

MIXED FOREST                  0   1   0
WHITE CEDAR SWAMP             0   0   0
MIXED SWAMP                   0   0   0
DISTURBED LAND                2.671   30  E
HIGH POCOSIN                  0   0   0
LOW POCOSIN                   0   0   0
BAY FOREST                    0   0   0
WATER AND MARSH               0   0   0
ACTIVE PEAT MINE              0   0   0
INACTIVE PEAT MINE            0   0   0
RESIDENTIAL DEVELOPMENT       0   0   0
ROADS AND RIGHTS-OF-WAY       0   0   0
OTHER DEVELOPED AREAS         0   0   0
AGRICULTURAL LAND             0   0   0
DECIDUOUS FOREST              0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 ,SCENARIO #2,
WITHOUT THE PROJECT.

FROM MIXED SWAMP  TO:

          TYPE                PRO BEG END R

DISTURBED LAND                3.751   80  E
HIGH POCOSIN                  0   0   0
LOW POCOSIN                   0   0   0
BAY FOREST                    0   0   0
WATER AND MARSH               0   0   0
ACTIVE PEAT MINE              0   0   0
INACTIVE PEAT MINE            0   0   0
RESIDENTIAL DEVELOPMENT       0   0   0
ROADS AND RIGHTS-OF-WAY       0   0   0
OTHER DEVELOPED AREAS         0   0   0
AGRICULTURAL LAND             0   0   0
DECIDUOUS FOREST              0   0   0
EVERGREEN FOREST              0   0   0
MIXED FOREST                  0   0   0
WHITE CEDAR SWAMP             0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 ,SCENARIO #2,
WITHOUT THE PROJECT.

FROM DISTURBED LAND       TO:

          TYPE                PRO BEG END R

HIGH POCOSIN                  4.7 1   20  E
LOW POCOSIN                   12.51   20  E
BAY FOREST                    0   0   0
WATER AND MARSH               0   0   0
ACTIVE PEAT MINE              0   1   0
INACTIVE PEAT MINE            0   0   0
RESIDENTIAL DEVELOPMENT       0   0   0
ROADS AND RIGHTS-OF-WAY       0   0   0
OTHER DEVELOPED AREAS         0   0   0
AGRICULTURAL LAND             0   0   0
DECIDUOUS FOREST              0   0   0
EVERGREEN FOREST              2.1 1   20  E
MIXED FOREST                  0   0   0
WHITE CEDAR SWAMP             0   0   0
MIXED SWAMP                   .8  1   20  E
```

```
HABITAT CONDITIONS,SCENARIO #2,
AT THE END OF THE PROJECT PERIOD.
AREA 2 WITHOUT THE PROJECT.

      TYPE                        ACRES

RESIDENTIAL DEVELOPMENT           0
ROADS AND RIGHTS-OF-WAY           0
OTHER DEVELOPED AREAS             0
AGRICULTURAL LAND                 1200
DECIDUOUS FOREST                  0
EVERGREEN FOREST                  901
MIXED FOREST                      0
WHITE CEDAR SWAMP                 0
MIXED SWAMP                       277
DISTURBED LAND                    214
HIGH POCOSIN                      3345
LOW POCOSIN                       8914
BAY FOREST                        0
WATER AND MARSH                   150
ACTIVE PEAT MINE                  0
INACTIVE PEAT MINE                0

                 TOTAL            15000
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2.SCENARIO #2.
WITHOUT THE PROJECT.

TYPE                 SPEC.
    1      2      3      4      5

1   0      0      0      0      0
2   0      0      0      0      0
3   0      0      0      0      0
4   288    636    216    456    900
5   0      0      0      0      0
6   434    510    260    33     467
7   0      0      0      0      0
8   0      0      0      0      0
9   284    214    258    100    55
10  278    432    237    89     414
11  2469   1999   1710   253    1140
12  6160   4388   5570   1097   2700
13  0      0      0      0      0
14  35     35     105    135    18
15  0      0      0      0      0
16  0      0      0      0      0

T   9948   8114   8355   2162   5694
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #2.
WITH THE PROJECT.

FROM AGRICULTURAL LAND TO:

          TYPE                PRO BEG END R

DECIDUOUS FOREST              0   0   0
EVERGREEN FOREST              0   0   0
MIXED FOREST                  0   0   0
WHITE CEDAR SWAMP             0   0   0
MIXED SWAMP                   0   0   0
DISTURBED LAND                0   0   0
HIGH POCOSIN                  0   0   0
LOW POCOSIN                   0   0   0
BAY FOREST                    0   0   0
WATER AND MARSH               0   0   0
ACTIVE PEAT MINE              60  1   20  F
INACTIVE PEAT MINE            0   0   0
RESIDENTIAL DEVELOPMENT 0     0   0
ROADS AND RIGHTS-OF-WAY 0     0   0
OTHER DEVELOPED AREAS         0   0   0
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2 . SCENARIO #2.
WITHOUT THE PROJECT.  (CONTINUED)

TYPE                 SPEC.              TOT.
    6      7      8      9      10

1   0      0      0      0      0      0
2   0      0      0      0      0      0
3   0      0      0      0      0      0
4   1020   480    96     48     336    4476
5   0      0      0      0      0      0
6   521    597    1042   716    575    5154
7   0      0      0      0      0      0
8   0      0      0      0      0      0
9   44     284    125    207    258    1830
10  313    343    59     95     384    2644
11  475    1203   1583   1646   2121   14499
12  1013   2785   2869   3038   5485   35106
13  0      0      0      0      0      0
14  5      23     0      0      38     392
15  0      0      0      0      0      0
16  0      0      0      0      0      0

T   3391   5714   5774   5750   9198   64100
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #2.
WITH THE PROJECT.

FROM EVERGREEN FOREST TO:

          TYPE                PRO BEG END R

MIXED FOREST                  0   1   0
WHITE CEDAR SWAMP             0   0   0
MIXED SWAMP                   0   0   0
DISTURBED LAND                0   1   0
HIGH POCOSIN                  0   0   0
LOW POCOSIN                   0   0   0
BAY FOREST                    0   0   0
WATER AND MARSH               0   0   0
ACTIVE PEAT MINE              60  1   20  F
INACTIVE PEAT MINE            0   0   0
RESIDENTIAL DEVELOPMENT 0     0   0
ROADS AND RIGHTS-OF-WAY 0     0   0
OTHER DEVELOPED AREAS         0   0   0
AGRICULTURAL LAND             0   0   0
DECIDUOUS FOREST              0   0   0
```

RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #2,
WITH THE PROJECT.

FROM MIXED SWAMP TO:

TYPE	PRO	BEG	END	R
DISTURBED LAND	0	1	0	
HIGH POCOSIN	0	0	0	
LOW POCOSIN	0	0	0	
BAY FOREST	0	0	0	
WATER AND MARSH	0	0	0	
ACTIVE PEAT MINE	22.5	1	20	F
INACTIVE PEAT MINE	0	0	0	
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	0	0	0	
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	0	0	0	
MIXED FOREST	0	0	0	
WHITE CEDAR SWAMP	0	0	0	

RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #2,
WITH THE PROJECT.

FROM DISTURBED LAND TO:

TYPE	PRO	BEG	END	R
HIGH POCOSIN	0	1	0	
LOW POCOSIN	0	1	0	
BAY FOREST	0	0	0	
WATER AND MARSH	0	0	0	
ACTIVE PEAT MINE	105	1	20	F
INACTIVE PEAT MINE	0	0	0	
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	0	0	0	
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	0	1	0	
MIXED FOREST	0	0	0	
WHITE CEDAR SWAMP	0	0	0	
MIXED SWAMP	0	1	0	

RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #2,
WITH THE PROJECT.

FROM HIGH POCOSIN TO:

TYPE	PRO	BEG	END	R
LOW POCOSIN	0	0	0	
BAY FOREST	0	0	0	
WATER AND MARSH	0	0	0	
ACTIVE PEAT MINE	135	1	20	F
INACTIVE PEAT MINE	0	0	0	
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	0	0	0	
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	0	0	0	
MIXED FOREST	0	0	0	
WHITE CEDAR SWAMP	0	0	0	
MIXED SWAMP	0	0	0	
DISTURBED LAND	0	0	0	

RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #2,
WITH THE PROJECT.

FROM LOW POCOSIN TO:

TYPE	PRO	BEG	END	R
BAY FOREST	0	0	0	
WATER AND MARSH	0	0	0	
ACTIVE PEAT MINE	360	1	20	F
INACTIVE PEAT MINE	0	0	0	
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	0	0	0	
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	0	0	0	
MIXED FOREST	0	0	0	
WHITE CEDAR SWAMP	0	0	0	
MIXED SWAMP	0	0	0	
DISTURBED LAND	0	0	0	
HIGH POCOSIN	0	0	0	

```
RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #2.
WITH THE PROJECT.

FROM WATER AND MARSH TO:

          TYPE              PRO BEG END R

ACTIVE PEAT MINE            7.5 1   20  F
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT     0   0   0
ROADS AND RIGHTS-OF-WAY     0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              0   0   0
HIGH POCOSIN                0   0   0
LOW POCOSIN                 0   0   0
BAY FOREST                  0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #2.
WITH THE PROJECT.

FROM ACTIVE PEAT MINE TO:

          TYPE              PRO BEG END R

INACTIVE PEAT MINE          750 2   20  F
RESIDENTIAL DEVELOPMENT     0   0   0
ROADS AND RIGHTS-OF-WAY     0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              0   0   0
HIGH POCOSIN                0   0   0
LOW POCOSIN                 0   0   0
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 . SCENARIO #2.
WITH THE PROJECT.

FROM INACTIVE PEAT MINE TO:

          TYPE              PRO BEG END R

RESIDENTIAL DEVELOPMENT     0   0   0
ROADS AND RIGHTS-OF-WAY     0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           66  5   20  T
BY YEAR
5 = 0      10 = 2280 15 = 6060 20 = 9840
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            3.2 5   20  T
BY YEAR
5 = 0      10 = 285  15 = 757.520 = 1230
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 .4  5   20  T
BY YEAR
5 = 0      10 = 12.4 15 = 32.9 20 = 53.5
DISTURBED LAND              0   0   0
HIGH POCOSIN                2.1 5   20  T
BY YEAR
5 = 0      10 = 74.3 15 = 197.720 = 320.9
LOW POCOSIN                 5.7 5   20  T
BY YEAR
5 = 0      10 = 198.315 = 526.920 = 855.6
BAY FOREST                  0   0   0
WATER AND MARSH             0   5   0
ACTIVE PEAT MINE            0   1   0
```

```
HABITAT CONDITIONS, SCENARIO #2.
AT THE END OF THE PROJECT PERIOD.
AREA 2 WITH THE PROJECT.

     TYPE                        ACRES

RESIDENTIAL DEVELOPMENT          0
ROADS AND RIGHTS-OF-WAY          0
OTHER DEVELOPED AREAS            0
AGRICULTURAL LAND                9840
DECIDUOUS FOREST                 0
EVERGREEN FOREST                 1230
MIXED FOREST                     0
WHITE CEDAR SWAMP                0
MIXED SWAMP                      54
DISTURBED LAND                   0
HIGH POCOSIN                     321
LOW POCOSIN                      856
BAY FOREST                       0
WATER AND MARSH                  0
ACTIVE PEAT MINE                 750
INACTIVE PEAT MINE               1950

               TOTAL             15000
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2 , SCENARIO #2,
WITH THE PROJECT.

TYPE                    SPEC.
    1       2       3       4       5

1   0       0       0       0       0
2   0       0       0       0       0
3   0       0       0       0       0
4   991     2189    744     1570    3098
5   0       0       0       0       0
6   406     477     244     30      437
7   0       0       0       0       0
8   0       0       0       0       0
9   179     135     163     63      35
10  469     728     399     150     698
11  1091    839     755     112     504
12  2723    1939    2462    485     1193
13  0       0       0       0       0
14  16      16      50      64      9
15  53      75      45      38      53
16  348     749     588     321     749

T   6276    7149    5449    2832    6775
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2 , SCENARIO #2.
WITH THE PROJECT.      (CONTINUED)

TYPE                    SPEC.                TOT.
    6       7       8       9       10

1   0       0       0       0       0        0
2   0       0       0       0       0        0
3   0       0       0       0       0        0
4   3511    1652    330     165     1157     15409
5   0       0       0       0       0        0
6   487     558     975     670     538      4822
7   0       0       0       0       0        0
8   0       0       0       0       0        0
9   28      179     79      131     163      1156
10  529     579     100     160     648      4459
11  210     531     699     727     937      6406
12  448     1231    1268    1343    2424     15515
13  0       0       0       0       0        0
14  2       11      0       0       18       186
15  53      38      0       0       23       375
16  695     615     160     160     588      4973

T   5962    5394    3612    3356    6496     53301
```

```
RATE OF HABITAT CONVERSION IN
AREA 3 , SCENARIO #2,
WITHOUT THE PROJECT.

FROM MIXED SWAMP  TO:

          TYPE                 PRO BEG END R

DISTURBED LAND                 26.251   30  E
HIGH POCOSIN                   0    0   0
LOW POCOSIN                    0    0   0
BAY FOREST                     0    0   0
WATER AND MARSH                0    0   0
ACTIVE PEAT MINE               0    1   0
INACTIVE PEAT MINE             0    0   0
RESIDENTIAL DEVELOPMENT        0    0   0
ROADS AND RIGHTS-OF-WAY        0    0   0
OTHER DEVELOPED AREAS          0    0   0
AGRICULTURAL LAND              0    0   0
DECIDUOUS FOREST               0    0   0
EVERGREEN FOREST               0    0   0
MIXED FOREST                   0    0   0
WHITE CEDAR SWAMP              0    0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 3 , SCENARIO #2.
WITHOUT THE PROJECT.

FROM DISTURBED LAND      TO:

          TYPE                 PRO BEG END R

HIGH POCOSIN                   12.41    30  E
LOW POCOSIN                    3.3 1    30  E
BAY FOREST                     0    0   0
WATER AND MARSH                0    0   0
ACTIVE PEAT MINE               0    1   0
INACTIVE PEAT MINE             0    0   0
RESIDENTIAL DEVELOPMENT        0    0   0
ROADS AND RIGHTS-OF-WAY        0    0   0
OTHER DEVELOPED AREAS          0    0   0
AGRICULTURAL LAND              0    0   0
DECIDUOUS FOREST               0    0   0
EVERGREEN FOREST               0    1   0
MIXED FOREST                   0    0   0
WHITE CEDAR SWAMP              0    0   0
MIXED SWAMP                    4.3 1    30  E
```

```
HABITAT CONDITIONS, SCENARIO #2.
AT THE END OF THE PROJECT PERIOD.
AREA 3 WITHOUT THE PROJECT.

      TYPE                           ACRES

RESIDENTIAL DEVELOPMENT             0
ROADS AND RIGHTS-OF-WAY             0
OTHER DEVELOPED AREAS               0
AGRICULTURAL LAND                   0
DECIDUOUS FOREST                    0
EVERGREEN FOREST                    0
MIXED FOREST                        0
WHITE CEDAR SWAMP                   0
MIXED SWAMP                         163
DISTURBED LAND                      533
HIGH POCOSIN                        19979
LOW POCOSIN                         5325
BAY FOREST                          0
WATER AND MARSH                     0
ACTIVE PEAT MINE                    0
INACTIVE PEAT MINE                  0

             TOTAL                  26000
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 3, SCENARIO #2.
WITHOUT THE PROJECT.

TYPE                  SPEC.
   1       2       3       4       5

1  0       0       0       0       0
2  0       0       0       0       0
3  0       0       0       0       0
4  0       0       0       0       0
5  0       0       0       0       0
6  0       0       0       0       0
7  0       0       0       0       0
8  0       0       0       0       0
9  796     599     723     279     155
10 824     1280    701     263     1227
11 14295   10996   9897    1466    6598
12 3567    2541    3225    635     1563
13 0       0       0       0       0
14 0       0       0       0       0
15 0       0       0       0       0
16 0       0       0       0       0

T  19482   15416   14546   2643    9544
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 3, SCENARIO #2.
WITHOUT THE PROJECT.  (CONTINUED)

TYPE                SPEC.               TOT.
   6       7       8       9       10

1  0       0       0       0       0       0
2  0       0       0       0       0       0
3  0       0       0       0       0       0
4  0       0       0       0       0       0
5  0       0       0       0       0       0
6  0       0       0       0       0       0
7  0       0       0       0       0       0
8  0       0       0       0       0       0
9  124     796     351     579     723     5126
10 929     1017    175     281     1140    7837
11 2749    6964    9164    9530    12279   83940
12 586     1612    1661    1759    3176    20325
13 0       0       0       0       0       0
14 0       0       0       0       0       0
15 0       0       0       0       0       0
16 0       0       0       0       0       0

T  4389    10389   11352   12148   17318   117228
```

```
RATE OF HABITAT CONVERSION IN
AREA 3, SCENARIO #2.
WITH THE PROJECT.

FROM MIXED SWAMP  TO:

          TYPE                  PRO BEG END R

DISTURBED LAND                  0   1   0
HIGH POCOSIN                    0   0   0
LOW POCOSIN                     0   0   0
BAY FOREST                      0   0   0
WATER AND MARSH                 0   0   0
ACTIVE PEAT MINE                273 1   20  F
INACTIVE PEAT MINE              0   0   0
RESIDENTIAL DEVELOPMENT         0   0   0
ROADS AND RIGHTS-OF-WAY         0   0   0
OTHER DEVELOPED AREAS           0   0   0
AGRICULTURAL LAND               0   0   0
DECIDUOUS FOREST                0   0   0
EVERGREEN FOREST                0   0   0
MIXED FOREST                    0   0   0
WHITE CEDAR SWAMP               0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 3. SCENARIO #2.
WITH THE PROJECT.

FROM DISTURBED LAND       TO:

        TYPE                PRO BEG END R

HIGH POCOSIN                0   1   0
LOW POCOSIN                 0   1   0
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
ACTIVE PEAT MINE            39  1   20  F
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT     0   0   0
ROADS AND RIGHTS-OF-WAY     0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   1   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   1   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 3. SCENARIO #2.
WITH THE PROJECT.

FROM HIGH POCOSIN TO:

        TYPE                PRO BEG END R

LOW POCOSIN                 0   0   0
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
ACTIVE PEAT MINE            790 1   20  F
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT     0   0   0
ROADS AND RIGHTS-OF-WAY     0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 3. SCENARIO #2.
WITH THE PROJECT.

FROM LOW POCOSIN TO:

        TYPE                PRO BEG END R

BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
ACTIVE PEAT MINE            208 1   20  F
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT     0   0   0
ROADS AND RIGHTS-OF-WAY     0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              0   0   0
HIGH POCOSIN                0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 3. SCENARIO #2.
WITH THE PROJECT.

FROM ACTIVE PEAT MINE TO:

        TYPE                PRO BEG END R

INACTIVE PEAT MINE          13002   20  F
RESIDENTIAL DEVELOPMENT     0   0   0
ROADS AND RIGHTS-OF-WAY     0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
DISTURBED LAND              0   0   0
HIGH POCOSIN                0   0   0
LOW POCOSIN                 0   0   0
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 3 . SCENARIO #2.
WITH THE PROJECT.

FROM INACTIVE PEAT MINE TO:

          TYPE               PRO BEG END R

RESIDENTIAL DEVELOPMENT 0    0    0
ROADS AND RIGHTS-OF-WAY 0    0    0
OTHER DEVELOPED AREAS   0    0    0
AGRICULTURAL LAND       65   5    20   T
BY YEAR
5 = 0      10 = 3120 15 = 9960 20 = 16800
DECIDUOUS FOREST         0    0    0
EVERGREEN FOREST         8.1 5    20   T
BY YEAR
5 = 0      10 = 390  15 = 1245 20 = 2100
MIXED FOREST             0    0    0
WHITE CEDAR SWAMP        0    0    0
MIXED SWAMP              1.755    20   T
BY YEAR
5 = 0      10 = 84.5 15 = 269.520 = 454.6
DISTURBED LAND           0    0    0
HIGH POCOSIN             5    5    20   T
BY YEAR
5 = 0      10 = 241.215 = 770.120 = 1299
LOW POCOSIN              1.3 5    20   T
BY YEAR
5 = 0      10 = 64.3 15 = 205.420 = 346.4
BAY FOREST               0    0    0
WATER AND MARSH          0    5    0
ACTIVE PEAT MINE         0    1    0
```

```
HABITAT CONDITIONS . SCENARIO #2,
AT THE END OF THE PROJECT PERIOD.
AREA 3 WITH THE PROJECT.

      TYPE                    ACRES

RESIDENTIAL DEVELOPMENT       0
ROADS AND RIGHTS-OF-WAY       0
OTHER DEVELOPED AREAS         0
AGRICULTURAL LAND             16800
DECIDUOUS FOREST              0
EVERGREEN FOREST              2100
MIXED FOREST                  0
WHITE CEDAR SWAMP             0
MIXED SWAMP                   455
DISTURBED LAND                0
HIGH POCOSIN                  1299
LOW POCOSIN                   346
BAY FOREST                    0
WATER AND MARSH               0
ACTIVE PEAT MINE              1300
INACTIVE PEAT MINE            3700

              TOTAL           26000
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 3 . SCENARIO #2.
WITH THE PROJECT.

TYPE                SPEC.
   1     2     3     4     5

1  0     0     0     0     0
2  0     0     0     0     0
3  0     0     0     0     0
4  1390  3069  1042  2200  4343
5  0     0     0     0     0
6  290   340   174   22    311
7  0     0     0     0     0
8  0     0     0     0     0
9  2118  1595  1925  743   413
10 174   270   148   56    259
11 6129  4715  4243  629   2829
12 1530  1090  1383  272   671
13 0     0     0     0     0
14 0     0     0     0     0
15 91    130   78    65    91
16 665   1432  1125  614   1432

T  12385 12640 10118 4600  10347
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 3, SCENARIO #2.
WITH THE PROJECT.      (CONTINUED)

TYPE                SPEC.              TOT.
   6     7     8     9     10

1  0     0     0     0     0     0
2  0     0     0     0     0     0
3  0     0     0     0     0     0
4  4922  2316  463   232   1621  21597
5  0     0     0     0     0     0
6  347   398   695   478   384   3438
7  0     0     0     0     0     0
8  0     0     0     0     0     0
9  330   2118  935   1540  1925  13641
10 196   215   37    59    241   1656
11 1179  2986  3929  4086  5265  35988
12 251   691   712   754   1362  8717
13 0     0     0     0     0     0
14 0     0     0     0     0     0
15 91    65    0     0     39    650
16 1329  1176  307   307   1125  9509

T  8646  9965  7078  7456  11961 95196
```

RATE OF HABITAT CONVERSION IN
AREA 4. SCENARIO #2.
WITHOUT THE PROJECT.

FROM WHITE CEDAR SWAMP TO:

TYPE	PRO	BEG	END	R
MIXED SWAMP	0	0	0	
DISTURBED LAND	1.251		30	E
HIGH POCOSIN	0	0	0	
LOW POCOSIN	0	0	0	
BAY FOREST	0	0	0	
WATER AND MARSH	0	0	0	
ACTIVE PEAT MINE	0	0	0	
INACTIVE PEAT MINE	0	0	0	
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	0	0	0	
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	0	0	0	
MIXED FOREST	0	0	0	

RATE OF HABITAT CONVERSION IN
AREA 4. SCENARIO #2.
WITHOUT THE PROJECT.

FROM MIXED SWAMP TO:

TYPE	PRO	BEG	END	R
DISTURBED LAND	35	1	30	E
HIGH POCOSIN	0	0	0	
LOW POCOSIN	0	0	0	
BAY FOREST	0	0	0	
WATER AND MARSH	0	0	0	
ACTIVE PEAT MINE	0	1	0	
INACTIVE PEAT MINE	0	0	0	
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	0	0	0	
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	0	0	0	
MIXED FOREST	0	0	0	
WHITE CEDAR SWAMP	0	0	0	

RATE OF HABITAT CONVERSION IN
AREA 4. SCENARIO #2.
WITHOUT THE PROJECT.

FROM DISTURBED LAND TO:

TYPE	PRO	BEG	END	R
HIGH POCOSIN	5.3	1	20	E
LOW POCOSIN	6.4	1	20	E
BAY FOREST	1.6	1	20	E
WATER AND MARSH	0	0	0	
ACTIVE PEAT MINE	0	1	0	
INACTIVE PEAT MINE	0	0	0	
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	0	0	0	
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	0	1	0	
MIXED FOREST	0	0	0	
WHITE CEDAR SWAMP	.2	1	20	E
MIXED SWAMP	6.4	1	20	E

RATE OF HABITAT CONVERSION IN
AREA 4. SCENARIO #2.
WITHOUT THE PROJECT.

FROM BAY FOREST TO:

TYPE	PRO	BEG	END	R
WATER AND MARSH	0	0	0	
ACTIVE PEAT MINE	0	0	0	
INACTIVE PEAT MINE	0	0	0	
RESIDENTIAL DEVELOPMENT	0	0	0	
ROADS AND RIGHTS-OF-WAY	0	0	0	
OTHER DEVELOPED AREAS	0	0	0	
AGRICULTURAL LAND	0	0	0	
DECIDUOUS FOREST	0	0	0	
EVERGREEN FOREST	0	0	0	
MIXED FOREST	0	0	0	
WHITE CEDAR SWAMP	0	0	0	
MIXED SWAMP	0	0	0	
DISTURBED LAND	7	1	100	E
HIGH POCOSIN	0	0	0	
LOW POCOSIN	0	0	0	

```
HABITAT CONDITIONS, SCENARIO #2,
AT THE END OF THE PROJECT PERIOD.
AREA 4 WITHOUT THE PROJECT.

     TYPE                         ACRES

RESIDENTIAL DEVELOPMENT           0
ROADS AND RIGHTS-OF-WAY           0
OTHER DEVELOPED AREAS             0
AGRICULTURAL LAND                 260
DECIDUOUS FOREST                  0
EVERGREEN FOREST                  0
MIXED FOREST                      0
WHITE CEDAR SWAMP                 165
MIXED SWAMP                       189
DISTURBED LAND                    308
HIGH POCOSIN                      4948
LOW POCOSIN                       6005
BAY FOREST                        495
WATER AND MARSH                   130
ACTIVE PEAT MINE                  0
INACTIVE PEAT MINE                0

           TOTAL                  13000
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 4. SCENARIO #2.
WITHOUT THE PROJECT.  (CONTINUED)

TYPE                 SPEC.                TOT.
    6      7      8      9      10

1   0      0      0      0      0       0
2   0      0      0      0      0       0
3   0      0      0      0      0       0
4   221    104    21     10     73      970
5   0      0      0      0      0       0
6   0      0      0      0      0       0
7   0      0      0      0      0       0
8   19     51     51     78     83      528
9   79     507    224    369    461     3263
10  966    1057   182    292    1185    8148
11  628    1592   2094   2178   2806    19182
12  610    1679   1730   1831   3306    21162
13  70     314    181    293    433     2708
14  4      20     0      0      33      339
15  0      0      0      0      0       0
16  0      0      0      0      0       0

T   2597   5323   4483   5051   8379    56302
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 4, SCENARIO #2,
WITHOUT THE PROJECT.

TYPE                SPEC.
    1      2      3      4      5

1   0      0      0      0      0
2   0      0      0      0      0
3   0      0      0      0      0
4   62     138    47     99     195
5   0      0      0      0      0
6   0      0      0      0      0
7   0      0      0      0      0
8   94     59     65     12     16
9   507    382    461    178    99
10  857    1331   729    273    1276
11  3267   2513   2262   335    1508
12  3713   2645   3357   661    1628
13  489    398    349    35     147
14  30     30     91     117    16
15  0      0      0      0      0
16  0      0      0      0      0

T   9018   7495   7361   1711   4883
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM AGRICULTURAL LAND TO:

          TYPE               PRO BEG END R

DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
LOW POCOSIN                  0   0   0
BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
ACTIVE PEAT MINE             13  1   20  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM WHITE CEDAR SWAMP TO:

          TYPE               PRO BEG END R

MIXED SWAMP                  0    0    0
DISTURBED LAND               0    1    0
HIGH POCOSIN                 0    0    0
LOW POCOSIN                  0    0    0
BAY FOREST                   0    0    0
WATER AND MARSH              0    0    0
ACTIVE PEAT MINE             6.5  1    20   F
INACTIVE PEAT MINE           0    0    0
RESIDENTIAL DEVELOPMENT      0    0    0
ROADS AND RIGHTS-OF-WAY      0    0    0
OTHER DEVELOPED AREAS        0    0    0
AGRICULTURAL LAND            0    0    0
DECIDUOUS FOREST             0    0    0
EVERGREEN FOREST             0    0    0
MIXED FOREST                 0    0    0
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM MIXED SWAMP  TO:

          TYPE               PRO BEG END R

DISTURBED LAND               0    1    0
HIGH POCOSIN                 0    0    0
LOW POCOSIN                  0    0    0
BAY FOREST                   0    0    0
WATER AND MARSH              0    0    0
ACTIVE PEAT MINE             182  1    20   F
INACTIVE PEAT MINE           0    0    0
RESIDENTIAL DEVELOPMENT      0    0    0
ROADS AND RIGHTS-OF-WAY      0    0    0
OTHER DEVELOPED AREAS        0    0    0
AGRICULTURAL LAND            0    0    0
DECIDUOUS FOREST             0    0    0
EVERGREEN FOREST             0    0    0
MIXED FOREST                 0    0    0
WHITE CEDAR SWAMP            0    0    0
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM DISTURBED LAND      TO:

          TYPE               PRO BEG END R

HIGH POCOSIN                 0    1    0
LOW POCOSIN                  0    1    0
BAY FOREST                   0    1    0
WATER AND MARSH              0    0    0
ACTIVE PEAT MINE             65   1    20   F
INACTIVE PEAT MINE           0    0    0
RESIDENTIAL DEVELOPMENT      0    0    0
ROADS AND RIGHTS-OF-WAY      0    0    0
OTHER DEVELOPED AREAS        0    0    0
AGRICULTURAL LAND            0    0    0
DECIDUOUS FOREST             0    0    0
EVERGREEN FOREST             0    1    0
MIXED FOREST                 0    0    0
WHITE CEDAR SWAMP            0    1    0
MIXED SWAMP                  0    1    0
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM HIGH POCOSIN TO:

          TYPE               PRO BEG END R

LOW POCOSIN                  0    0    0
BAY FOREST                   0    0    0
WATER AND MARSH              0    0    0
ACTIVE PEAT MINE             149.51   20   F
INACTIVE PEAT MINE           0    0    0
RESIDENTIAL DEVELOPMENT      0    0    0
ROADS AND RIGHTS-OF-WAY      0    0    0
OTHER DEVELOPED AREAS        0    0    0
AGRICULTURAL LAND            0    0    0
DECIDUOUS FOREST             0    0    0
EVERGREEN FOREST             0    0    0
MIXED FOREST                 0    0    0
WHITE CEDAR SWAMP            0    0    0
MIXED SWAMP                  0    0    0
DISTURBED LAND               0    0    0
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM LOW POCOSIN TO:

          TYPE               PRO BEG END R

BAY FOREST                   0   0   0
WATER AND MARSH              0   1   0
ACTIVE PEAT MINE             182 1   20  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM BAY FOREST TO:

          TYPE               PRO BEG END R

WATER AND MARSH              0   0   0
ACTIVE PEAT MINE             45.51   20  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   1   0
HIGH POCOSIN                 0   0   0
LOW POCOSIN                  0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM WATER AND MARSH TO:

          TYPE               PRO BEG END R

ACTIVE PEAT MINE             6.5 1   20  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
LOW POCOSIN                  0   0   0
BAY FOREST                   0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM ACTIVE PEAT MINE TO:

          TYPE               PRO BEG END R

INACTIVE PEAT MINE           650 2   20  F
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
LOW POCOSIN                  0   0   0
BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 4, SCENARIO #2,
WITH THE PROJECT.

FROM INACTIVE PEAT MINE TO:

          TYPE              PRO BEG END R

RESIDENTIAL DEVELOPMENT 18   5   20   T
BY YEAR
5 = 0       10 = 106  15 = 331  20 = 2354
ROADS AND RIGHTS-OF-WAY 0    0    0
OTHER DEVELOPED AREAS   0    0    0
AGRICULTURAL LAND       1.7 5    20   T
BY YEAR
5 = 0       10 = 53   15 = 69   20 = 214
DECIDUOUS FOREST        0    0    0
EVERGREEN FOREST        15   5    20   T
BY YEAR
5 = 0       10 = 264  15 = 430  20 = 1926
MIXED FOREST            0    0    0
WHITE CEDAR SWAMP       1    5    20   T
BY YEAR
5 = 0       10 = 3    15 = 4.9  20 = 22
MIXED SWAMP             4.8 5    20   T
BY YEAR
5 = 0       10 = 85   15 = 138.420 = 620
DISTURBED LAND          0    0    0
HIGH POCOSIN            3.9 5    20   T
BY YEAR
5 = 0       10 = 69.8 15 = 113.720 = 509
LOW POCOSIN             4.8 5    20   T
BY YEAR
5 = 0       10 = 85   15 = 138.420 = 620
BAY FOREST              1.2 5    20   T
BY YEAR
5 = 0       10 = 21.2 15 = 34.6 20 = 155
WATER AND MARSH         33   5    20   T
BY YEAR
5 = 0       10 = 1954 15 = 2187 20 = 4280
ACTIVE PEAT MINE        0    1    0
```

```
HABITAT CONDITIONS, SCENARIO #2,
AT THE END OF THE PROJECT PERIOD.
AREA 4 WITH THE PROJECT.

    TYPE                         ACRES

RESIDENTIAL DEVELOPMENT          2354
ROADS AND RIGHTS-OF-WAY          0
OTHER DEVELOPED AREAS            0
AGRICULTURAL LAND                214
DECIDUOUS FOREST                 0
EVERGREEN FOREST                 1926
MIXED FOREST                     0
WHITE CEDAR SWAMP                22
MIXED SWAMP                      620
DISTURBED LAND                   0
HIGH POCOSIN                     509
LOW POCOSIN                      620
BAY FOREST                       155
WATER AND MARSH                  4280
ACTIVE PEAT MINE                 650
INACTIVE PEAT MINE               1650

            TOTAL                13000
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 4, SCENARIO #2.
WITH THE PROJECT.

TYPE                 SPEC.
    1      2      3      4      5

1   0      9      9      23     51
2   0      0      0      0      0
3   0      0      0      0      0
4   45     99     33     71     140
5   0      0      0      0      0
6   185    217    111    14     199
7   0      0      0      0      0
8   40     25     28     5      7
9   1446   1089   1314   507    282
10  290    451    247    93     432
11  1203   925    833    123    555
12  1371   976    1239   244    601
13  329    268    235    23     99
14  400    400    1217   1565   209
15  46     65     39     33     46
16  396    853    671    366    853

T   5750   5379   5977   3067   3472
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #3.
WITHOUT THE PROJECT.

FROM DISTURBED LAND       TO:

          TYPE              PRO BEG END R

HIGH POCOSIN                3.5 1   20  E
LOW POCOSIN                 16.51   20  E
BAY FOREST                  0   0   0
WATER AND MARSH             0   0   0
ACTIVE PEAT MINE            0   0   0
INACTIVE PEAT MINE          0   0   0
RESIDENTIAL DEVELOPMENT     0   0   0
ROADS AND RIGHTS-OF-WAY     0   0   0
OTHER DEVELOPED AREAS       0   0   0
AGRICULTURAL LAND           0   0   0
DECIDUOUS FOREST            0   0   0
EVERGREEN FOREST            0   0   0
MIXED FOREST                0   0   0
WHITE CEDAR SWAMP           0   0   0
MIXED SWAMP                 0   0   0
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 4, SCENARIO #2,
WITH THE PROJECT.     (CONTINUED)

TYPE                 SPEC.              TOT.
    6      7      8      9      10

1   139    14     23     60     9       338
2   0      0      0      0      0       0
3   0      0      0      0      0       0
4   158    74     15     7      52      694
5   0      0      0      0      0       0
6   222    254    444    305    245     2196
7   0      0      0      0      0       0
8   8      22     22     34     36      227
9   225    1446   638    1052   1314    9314
10  327    358    62     99     401     2760
11  231    586    771    802    1033    7065
12  225    620    638    676    1221    7812
13  47     211    122    197    291     1821
14  52     261    0      0      435     4539
15  46     33     0      0      20      325
16  792    701    183    183    671     5669

T   2473   4580   2919   3415   5728    4276
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #3.
WITHOUT THE PROJECT.

FROM INACTIVE PEAT MINE TO:

        TYPE                PRO BEG END R

RESIDENTIAL DEVELOPMENT 0   0   0
ROADS AND RIGHTS-OF-WAY 0   0   0
OTHER DEVELOPED AREAS   0   0   0
AGRICULTURAL LAND       0   0   0
DECIDUOUS FOREST        0   0   0
EVERGREEN FOREST        0   0   0
MIXED FOREST            0   0   0
WHITE CEDAR SWAMP       0   0   0
MIXED SWAMP             0   0   0
DISTURBED LAND          0   0   0
HIGH POCOSIN            0   0   0
LOW POCOSIN             0   0   0
BAY FOREST              0   0   0
WATER AND MARSH         100 5   20  T
BY YEAR
5 = 0     10 = 316  15 = 316  20 = 316
ACTIVE PEAT MINE        0   0   0
```

```
HABITAT CONDITIONS.SCENARIO #3.
AT THE END OF THE PROJECT PERIOD.
AREA 1 WITHOUT THE PROJECT.

      TYPE                          ACRES

RESIDENTIAL DEVELOPMENT             0
ROADS AND RIGHTS-OF-WAY             0
OTHER DEVELOPED AREAS               0
AGRICULTURAL LAND                   2848
DECIDUOUS FOREST                    0
EVERGREEN FOREST                    0
MIXED FOREST                        0
WHITE CEDAR SWAMP                   0
MIXED SWAMP                         0
DISTURBED LAND                      100
HIGH POCOSIN                        2138
LOW POCOSIN                         10100
BAY FOREST                          0
WATER AND MARSH                     632
ACTIVE PEAT MINE                    0
INACTIVE PEAT MINE                  0

             TOTAL                  15818
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1.SCENARIO #3.
WITHOUT THE PROJECT.

TYPE                      SPEC.
   1        2        3        4        5

1  0        0        0        0        0
2  0        0        0        0        0
3  0        0        0        0        0
4  634      1509     513      1082     2136
5  0        0        0        0        0
6  0        0        0        0        0
7  0        0        0        0        0
8  0        0        0        0        0
9  0        0        0        0        0
10 809      1256     688      253      1204
11 1447     1113     1001     148      668
12 6397     4557     5784     1139     2804
13 0        0        0        0        0
14 120      120      365      469      63
15 0        0        0        0        0
16 14       31       24       13       31

T  9470     8586     8375     3110     6905
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1.SCENARIO #3.
WITHOUT THE PROJECT.  (CONTINUED)

TYPE                 SPEC.             TOT.
   6        7        8        9        10

1  0        0        0        0        0        0
2  0        0        0        0        0        0
3  0        0        0        0        0        0
4  2421     1139     228      114      797      10623
5  0        0        0        0        0        0
6  0        0        0        0        0        0
7  0        0        0        0        0        0
8  0        0        0        0        0        0
9  0        0        0        0        0        0
10 912      998      172      275      1119     7688
11 278      705      927      964      1243     6494
12 1052     2892     2980     3155     5696     36456
13 0        0        0        0        0        0
14 16       78       0        0        130      1361
15 0        0        0        0        0        0
16 29       25       7        7        24       206

T  4707     5837     4313     4515     9009     64823
```

```
RATE OF HABITAT CONVERSION IN
AREA 1.SCENARIO #3.
WITH THE PROJECT.

FROM AGRICULTURAL LAND TO:

          TYPE                PRO BEG END R

DECIDUOUS FOREST              0   0   0
EVERGREEN FOREST              0   0   0
MIXED FOREST                  0   0   0
WHITE CEDAR SWAMP             0   0   0
MIXED SWAMP                   0   0   0
DISTURBED LAND                0   0   0
HIGH POCOSIN                  0   0   0
LOW POCOSIN                   0   0   0
BAY FOREST                    0   0   0
WATER AND MARSH               0   0   0
ACTIVE PEAT MINE              102 1   10  F
INACTIVE PEAT MINE            0   0   0
RESIDENTIAL DEVELOPMENT       0   0   0
ROADS AND RIGHTS-OF-WAY       0   0   0
OTHER DEVELOPED AREAS         0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1 .SCENARIO #3,
WITH THE PROJECT.

FROM DISTURBED LAND      TO:

         TYPE                PRO BEG END R

HIGH POCOSIN                 0   1   0
LOW POCOSIN                  0   1   0
BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
ACTIVE PEAT MINE             313 1   10  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1 .SCENARIO #3,
WITH THE PROJECT.

FROM HIGH POCOSIN TO:

         TYPE                PRO BEG END R

LOW POCOSIN                  0   0   0
BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
ACTIVE PEAT MINE             23  1   10  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1 .SCENARIO #3,
WITH THE PROJECT.

FROM LOW POCOSIN TO:

         TYPE                PRO BEG END R

BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
ACTIVE PEAT MINE             108 1   10  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1 .SCENARIO #3,
WITH THE PROJECT.

FROM WATER AND MARSH TO:

         TYPE                PRO BEG END R

ACTIVE PEAT MINE             11  1   10  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
LOW POCOSIN                  0   0   0
BAY FOREST                   0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 1 ,SCENARIO #3,
WITH THE PROJECT.

FROM ACTIVE PEAT MINE TO:

         TYPE                 PRO BEG END R

INACTIVE PEAT MINE            568 2   11  F
RESIDENTIAL DEVELOPMENT 0     0   0
ROADS AND RIGHTS-OF-WAY 0     0   0
OTHER DEVELOPED AREAS   0     0   0
AGRICULTURAL LAND       0     0   0
DECIDUOUS FOREST        0     0   0
EVERGREEN FOREST        0     0   0
MIXED FOREST            0     0   0
WHITE CEDAR SWAMP       0     0   0
MIXED SWAMP             0     0   0
DISTURBED LAND          0     0   0
HIGH POCOSIN            0     0   0
LOW POCOSIN             0     0   0
BAY FOREST              0     0   0
WATER AND MARSH         0     0   0
```

```
HABITAT CONDITIONS ,SCENARIO #3,
AT THE END OF THE PROJECT PERIOD.
AREA 1 WITH THE PROJECT.

     TYPE                         ACRES

RESIDENTIAL DEVELOPMENT           0
ROADS AND RIGHTS-OF-WAY           0
OTHER DEVELOPED AREAS             0
AGRICULTURAL LAND                 1828
DECIDUOUS FOREST                  0
EVERGREEN FOREST                  0
MIXED FOREST                      0
WHITE CEDAR SWAMP                 0
MIXED SWAMP                       0
DISTURBED LAND                    5570
HIGH POCOSIN                      403
LOW POCOSIN                       1925
BAY FOREST                        0
WATER AND MARSH                   6092
ACTIVE PEAT MINE                  0
INACTIVE PEAT MINE                0

            TOTAL                 15818
```

```
RATE OF HABITAT CONVERSION IN
AREA 1 ,SCENARIO #3,
WITH THE PROJECT.

FROM INACTIVE PEAT MINE TO:

         TYPE                 PRO BEG END R

RESIDENTIAL DEVELOPMENT 0     0   0
ROADS AND RIGHTS-OF-WAY 0     0   0
OTHER DEVELOPED AREAS   0     0   0
AGRICULTURAL LAND       3     5   20  T
BY YEAR
5 = 0      10 = 162  15 = 0    20 = 0
DECIDUOUS FOREST        0     0   0
EVERGREEN FOREST        4     5   20  T
BY YEAR
5 = 0      10 = 202  15 = 0    20 = 0
MIXED FOREST            0     0   0
WHITE CEDAR SWAMP       0     0   0
MIXED SWAMP             0     0   0
DISTURBED LAND          0     0   0
HIGH POCOSIN            2     5   20  T
BY YEAR
5 = 0      10 = 35   15 = 0    20 = 0
LOW POCOSIN             4     5   20  T
BY YEAR
5 = 0      10 = 167  15 = 0    20 = 0
BAY FOREST              0     0   0
WATER AND MARSH         100 5     20  T
BY YEAR
5 = 0      10 = 1454 15 = 5886 20 = 588
ACTIVE PEAT MINE        11    1   10  F
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1,SCENARIO #3,
WITH THE PROJECT.

TYPE                   SPEC.
   1      2      3      4      5

1  0      0      0      0      0
2  0      0      0      0      0
3  0      0      0      0      0
4  504    1112   378    797    1578
5  0      0      0      0      0
6  20     24     12     2      22
7  0      0      0      0      0
8  0      0      0      0      0
9  0      0      0      0      0
10 2949   4580   2510   941    4392
11 362    278    250    87     167
12 1613   1149   1458   287    707
13 0      0      0      0      0
14 678    678    2064   2654   354
15 20     28     17     14     20
16 194    417    328    179    417

T  6339   8267   7017   4911   7652
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 1 .SCENARIO #3.
WITH THE PROJECT.     (CONTINUED)

TYPE                  SPEC.              TOT.
    6      7      8      9      10

1   0      0      0      0      0      0
2   0      0      0      0      0      0
3   0      0      0      0      0      0
4   1783   839    168    84     587    7826
5   0      0      0      0      0      0
6   24     28     48     33     27     240
7   0      0      0      0      0      0
8   0      0      0      0      0      0
9   0      0      0      0      0      0
10  3325   3639   627    1004   4078   28046
11  70     176    232    241    311    2123
12  265    729    751    796    1436   9193
13  0      0      0      0      0      0
14  88     442    0      0      737    7696
15  20     14     0      0      9      142
16  387    343    89     89     328    2770

T   5963   6210   1916   2247   7513   58035
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 .SCENARIO #3.
WITHOUT THE PROJECT.

FROM EVERGREEN FOREST TO:

          TYPE             PRO BEG END R

MIXED FOREST               0   0   0
WHITE CEDAR SWAMP          0   0   0
MIXED SWAMP                0   0   0
DISTURBED LAND             3.3 1   30  E
HIGH POCOSIN               0   0   0
LOW POCOSIN                0   0   0
BAY FOREST                 0   0   0
WATER AND MARSH            0   0   0
ACTIVE PEAT MINE           0   0   0
INACTIVE PEAT MINE         0   0   0
RESIDENTIAL DEVELOPMENT    0   0   0
ROADS AND RIGHTS-OF-WAY    0   0   0
OTHER DEVELOPED AREAS      0   0   0
AGRICULTURAL LAND          0   0   0
DECIDUOUS FOREST           0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 .SCENARIO #3.
WITHOUT THE PROJECT.

FROM MIXED SWAMP  TO:

          TYPE             PRO BEG END R

DISTURBED LAND             1.251   80  E
HIGH POCOSIN               0   0   0
LOW POCOSIN                0   0   0
BAY FOREST                 0   0   0
WATER AND MARSH            0   0   0
ACTIVE PEAT MINE           0   0   0
INACTIVE PEAT MINE         0   0   0
RESIDENTIAL DEVELOPMENT    0   0   0
ROADS AND RIGHTS-OF-WAY    0   0   0
OTHER DEVELOPED AREAS      0   0   0
AGRICULTURAL LAND          0   0   0
DECIDUOUS FOREST           0   0   0
EVERGREEN FOREST           0   0   0
MIXED FOREST               0   0   0
WHITE CEDAR SWAMP          0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 .SCENARIO #3.
WITHOUT THE PROJECT.

FROM DISTURBED LAND     TO:

          TYPE             PRO BEG END R

HIGH POCOSIN               7.7 1   20  E
LOW POCOSIN                5.9 1   20  E
BAY FOREST                 0   0   0
WATER AND MARSH            0   0   0
ACTIVE PEAT MINE           0   1   0
INACTIVE PEAT MINE         0   0   0
RESIDENTIAL DEVELOPMENT    0   0   0
ROADS AND RIGHTS-OF-WAY    0   0   0
OTHER DEVELOPED AREAS      0   0   0
AGRICULTURAL LAND          0   0   0
DECIDUOUS FOREST           0   0   0
EVERGREEN FOREST           5.9 1   20  E
MIXED FOREST               0   0   0
WHITE CEDAR SWAMP          0   0   0
MIXED SWAMP                .4  1   20  E
```

```
HABITAT CONDITIONS ,SCENARIO #3.
AT THE END OF THE PROJECT PERIOD.
AREA 2 WITHOUT THE PROJECT.

      TYPE                       ACRES

RESIDENTIAL DEVELOPMENT          0
ROADS AND RIGHTS-OF-WAY          0
OTHER DEVELOPED AREAS            0
AGRICULTURAL LAND                1071
DECIDUOUS FOREST                 0
EVERGREEN FOREST                 1147
MIXED FOREST                     0
WHITE CEDAR SWAMP                0
MIXED SWAMP                      115
DISTURBED LAND                   245
HIGH POCOSIN                     2585
LOW POCOSIN                      1979
BAY FOREST                       0
WATER AND MARSH                  0
ACTIVE PEAT MINE                 0
INACTIVE PEAT MINE               0

            TOTAL                7142
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2 ,SCENARIO #3,
WITHOUT THE PROJECT.

TYPE                 SPEC.
    1      2      3      4      5

1   0      0      0      0      0
2   0      0      0      0      0
3   0      0      0      0      0
4   257    563    193    407    803
5   0      0      0      0      0
6   509    598    305    38     547
7   0      0      0      0      0
8   0      0      0      0      0
9   85     64     77     30     17
10  355    552    302    113    529
11  1737   1336   1203   178    802
12  1245   887    1125   222    546
13  0      0      0      0      0
14  0      0      0      0      0
15  0      0      0      0      0
16  0      0      0      0      0

T   4188   4004   3206   988    3244
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2 . SCENARIO #3,
WITHOUT THE PROJECT.  (CONTINUED)

TYPE                SPEC.               TOT.
    6      7      8      9      10

1   0      0      0      0      0      0
2   0      0      0      0      0      0
3   0      0      0      0      0      0
4   910    428    86     43     300    3995
5   0      0      0      0      0      0
6   611    700    1222   840    674    6045
7   0      0      0      0      0      0
8   0      0      0      0      0      0
9   13     85     37     62     77     547
10  401    438    76     121    491    3379
11  334    846    1114   1158   1492   10200
12  205    563    580    614    1108   7094
13  0      0      0      0      0      0
14  0      0      0      0      0      0
15  0      0      0      0      0      0
16  0      0      0      0      0      0

T   2474   3061   3114   2837   4143   31259
```

```
RATE OF HABITAT CONVERSION IN
AREA 2 , SCENARIO #3.
WITH THE PROJECT.

FROM AGRICULTURAL LAND TO:

         TYPE                PRO BEG END F

DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
LOW POCOSIN                  0   0   0
BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
ACTIVE PEAT MINE             45  1   10  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2, SCENARIO #3,
WITH THE PROJECT.

FROM EVERGREEN FOREST TO:

          TYPE             PRO BEG END R

MIXED FOREST               0   0   0
WHITE CEDAR SWAMP          0   0   0
MIXED SWAMP                0   0   0
DISTURBED LAND             0   1   0
HIGH POCOSIN               0   0   0
LOW POCOSIN                0   0   0
BAY FOREST                 0   0   0
WATER AND MARSH            0   0   0
ACTIVE PEAT MINE           39  1   10  F
INACTIVE PEAT MINE         0   0   0
RESIDENTIAL DEVELOPMENT    0   0   0
ROADS AND RIGHTS-OF-WAY    0   0   0
OTHER DEVELOPED AREAS      0   0   0
AGRICULTURAL LAND          0   0   0
DECIDUOUS FOREST           0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2, SCENARIO #3,
WITH THE PROJECT.

FROM MIXED SWAMP  TO:

          TYPE             PRO BEG END R

DISTURBED LAND             0   1   0
HIGH POCOSIN               0   0   0
LOW POCOSIN                0   0   0
BAY FOREST                 0   0   0
WATER AND MARSH            0   0   0
ACTIVE PEAT MINE           3   1   10  F
INACTIVE PEAT MINE         0   0   0
RESIDENTIAL DEVELOPMENT    0   0   0
ROADS AND RIGHTS-OF-WAY    0   0   0
OTHER DEVELOPED AREAS      0   0   0
AGRICULTURAL LAND          0   0   0
DECIDUOUS FOREST           0   0   0
EVERGREEN FOREST           0   0   0
MIXED FOREST               0   0   0
WHITE CEDAR SWAMP          0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2, SCENARIO #3.
WITH THE PROJECT.

FROM DISTURBED LAND        TO:

          TYPE             PRO BEG END R

HIGH POCOSIN               0   1   0
LOW POCOSIN                0   1   0
BAY FOREST                 0   0   0
WATER AND MARSH            0   0   0
ACTIVE PEAT MINE           123 1   10  F
INACTIVE PEAT MINE         0   0   0
RESIDENTIAL DEVELOPMENT    0   0   0
ROADS AND RIGHTS-OF-WAY    0   0   0
OTHER DEVELOPED AREAS      0   0   0
AGRICULTURAL LAND          0   0   0
DECIDUOUS FOREST           0   0   0
EVERGREEN FOREST           0   1   0
MIXED FOREST               0   0   0
WHITE CEDAR SWAMP          0   0   0
MIXED SWAMP                0   1   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2, SCENARIO #3,
WITH THE PROJECT.

FROM HIGH POCOSIN TO:

          TYPE             PRO BEG END R

LOW POCOSIN                0   0   0
BAY FOREST                 0   0   0
WATER AND MARSH            0   0   0
ACTIVE PEAT MINE           51  1   10  F
INACTIVE PEAT MINE         0   0   0
RESIDENTIAL DEVELOPMENT    0   0   0
ROADS AND RIGHTS-OF-WAY    0   0   0
OTHER DEVELOPED AREAS      0   0   0
AGRICULTURAL LAND          0   0   0
DECIDUOUS FOREST           0   0   0
EVERGREEN FOREST           0   0   0
MIXED FOREST               0   0   0
WHITE CEDAR SWAMP          0   0   0
MIXED SWAMP                0   0   0
DISTURBED LAND             0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2. SCENARIO #3.
WITH THE PROJECT.

FROM LOW POCOSIN TO:

         TYPE                PRO BEG END R

BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
ACTIVE PEAT MINE             39  1   10  F
INACTIVE PEAT MINE           0   0   0
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2. SCENARIO #3.
WITH THE PROJECT.

FROM ACTIVE PEAT MINE TO:

         TYPE                PRO BEG END R

INACTIVE PEAT MINE           300 2   11  F
RESIDENTIAL DEVELOPMENT      0   0   0
ROADS AND RIGHTS-OF-WAY      0   0   0
OTHER DEVELOPED AREAS        0   0   0
AGRICULTURAL LAND            0   0   0
DECIDUOUS FOREST             0   0   0
EVERGREEN FOREST             0   0   0
MIXED FOREST                 0   0   0
WHITE CEDAR SWAMP            0   0   0
MIXED SWAMP                  0   0   0
DISTURBED LAND               0   0   0
HIGH POCOSIN                 0   0   0
LOW POCOSIN                  0   0   0
BAY FOREST                   0   0   0
WATER AND MARSH              0   0   0
```

```
RATE OF HABITAT CONVERSION IN
AREA 2. SCENARIO #3.
WITH THE PROJECT.

FROM INACTIVE PEAT MINE TO:

         TYPE                PRO BEG END R

RESIDENTIAL DEVELOPMENT 0    0    0
ROADS AND RIGHTS-OF-WAY 0    0    0
OTHER DEVELOPED AREAS   0    0    0
AGRICULTURAL LAND       4    5    20   T
BY YEAR
5 = 0      10 = 1200 15 = 0     20 = 0
DECIDUOUS FOREST        0    0    0
EVERGREEN FOREST        5    5    20   T
BY YEAR
5 = 0      10 = 150  15 = 0     20 = 0
MIXED FOREST            0    0    0
WHITE CEDAR SWAMP       0    0    0
MIXED SWAMP             1    5    20   T
BY YEAR
5 = 0      10 = 5    15 = 0     20 = 0
DISTURBED LAND          0    0    0
HIGH POCOSIN            6    5    20   T
BY YEAR
5 = 0      10 = 82   15 = 0     20 = 0
LOW POCOSIN             5    5    20   T
BY YEAR
5 = 0      10 = 63   15 = 0     20 = 0
BAY FOREST              0    0    0
WATER AND MARSH         100  11   20   T
BY YEAR
5 = 0      10 = 0    15 = 3000 20 = 3000
ACTIVE PEAT MINE        0    1    0
```

```
HABITAT CONDITIONS. SCENARIO #3.
AT THE END OF THE PROJECT PERIOD.
AREA 2 WITH THE PROJECT.

     TYPE                          ACRES

RESIDENTIAL DEVELOPMENT            0
ROADS AND RIGHTS-OF-WAY            0
OTHER DEVELOPED AREAS              0
AGRICULTURAL LAND                  621
DECIDUOUS FOREST                   0
EVERGREEN FOREST                   539
MIXED FOREST                       0
WHITE CEDAR SWAMP                  0
MIXED SWAMP                        41
DISTURBED LAND                     1698
HIGH POCOSIN                       704
LOW POCOSIN                        539
BAY FOREST                         0
WATER AND MARSH                    3000
ACTIVE PEAT MINE                   0
INACTIVE PEAT MINE                 0

              TOTAL                7142
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2. SCENARIO #3.
WITH THE PROJECT.      (CONTINUED)

TYPE                SPEC.             TOT.
    6       7       8      9      10

1   0       0       0      0      0      0
2   0       0       0      0      0      0
3   0       0       0      0      0      0
4   869     409     82     41     286    3813
5   0       0       0      0      0      0
6   319     365     638    438    352    3155
7   0       0       0      0      0      0
8   0       0       0      0      0      0
9   6       38      17     27     34     243
10  1047    1145    197    316    1284   8827
11  126     319     420    436    562    3844
12  77      212     218    231    418    2673
13  0       0       0      0      0      0
14  36      180     0      0      300    3132
15  11      8       0      0      5      75
16  156     138     36     36     132    1116

T   2646    2814    1608   1526   3373   26878
```

```
ACCRUED ANNUALIZED HABITAT UNITS
AT THE END OF THE PROJECT PERIOD.
AREA 2 . SCENARIO #3.
WITH THE PROJECT.

TYPE                      SPEC.
    1       2       3       4       5

1   0       0       0       0       0
2   0       0       0       0       0
3   0       0       0       0       0
4   245     542     184     388     767
5   0       0       0       0       0
6   266     312     159     20      286
7   0       0       0       0       0
8   0       0       0       0       0
9   38      28      34      13      7
10  928     1442    790     296     1382
11  655     504     453     67      302
12  469     334     424     84      206
13  0       0       0       0       0
14  276     276     840     1080    144
15  11      15      9       8       11
16  78      168     132     72      168

T   2965    3621    3026    2028    3272
```

10.5 Appendix for Section 6.2.1.1: Amount of Surface Water Runoff

Table 10.5A: Scenario #1, Area 1: Acreage by land use categories for the 20 year study period.

YEAR	OPEN WATER*	PRE-MINING DISTURBED	PRE-MINING SHRUB	PEAT MINE	RECLAIMED AGRIC	RECLAIMED FOREST
0	330	11160	4000	330	0	0
1	2660	8400	4000	750	0	0
2	2660	6990	4000	2160	0	0
3	2660	6900	3670	2580	0	0
4	2660	6820	3340	3000	0	0
5	2660	6400	3340	3410	0	0
6	3000	5990	3340	3330	170	0
7	3160	5570	3340	3580	170	0
8	3500	5490	3340	3330	170	0
9	4000	4740	3000	3750	270	70
10	1670	7320	2670	3500	530	130
11	1670	6990	2670	2660	1470	370
12	1670	6320	2340	3000	2000	500
13	1670	5990	2340	2330	2800	700
14	1670	5660	2000	2660	3060	770
15	1670	5320	1670	2660	3600	900
16	1670	4660	1670	2660	4130	1030
17	1670	4660	1340	2330	4660	1170
18	1670	4660	670	3000	4660	1170
19	1670	4660	340	2330	5460	1370
20	1670	4660	0	2000	5990	1500

*Note: OPEN WATER includes the temporary lagoon, permanent lake and an estimate of the canal surface area.

Table 10.5B: Scenario #1, Area 2: Acreage by land use categories for the 20 year study period.

	PRE-MINING		PEAT	RECLAIMED	
YEAR	DISTURBED	SHRUB	MINE	AGRIC	FOREST
0	2140	4000	0	0	1000
1	2050	3830	300	0	960
2	1960	3660	600	0	920
3	1870	3490	900	0	880
4	1780	3320	1200	0	840
5	1690	3150	1500	0	800
6	1600	2980	1800	0	760
7	1510	2810	1800	300	720
8	1420	2640	1800	600	680
9	1330	2470	1800	720	820
10	1249	2300	1800	960	840
11	1150	2130	1800	1200	860
12	1060	1960	1800	1440	880
13	970	1790	1800	1680	900
14	880	1620	1800	1920	920
15	790	1450	1800	2160	940
16	700	1280	1800	2400	960
17	610	1110	1800	2640	980
18	520	940	1800	2880	1000
19	430	770	1800	3120	1020
20	340	600	1800	3360	1040

Table 10.5C: Scenario #2, Area 1: Acreage by land use categories for the 20 year study period.

	OPEN	PRE-MINING		PEAT	RECLAIMED	
YEAR	WATER	DISTURBED	SHRUB	MINE	AGRIC	FOREST
0	300	12300	17100	300	0	0
1	5000	7250	16250	1500	0	0
2	5000	6600	15400	3000	0	0
3	5000	5950	14550	4500	0	0
4	5000	5300	13700	6000	0	0
5	5000	4650	12850	7500	0	0
6	6500	4120	11380	8000	0	0
7	8000	3590	9910	8500	0	0
8	8000	3060	8440	9000	1500	0
9	3000	7530	6970	9500	2400	600
10	3000	7000	5500	10000	3600	900
11	3000	5600	4400	10500	5200	1300
12	3000	4200	3300	11000	6800	1700
13	3000	2800	2200	11500	8400	2100
14	3000	1400	1100	12000	10000	2500
15	3000	0	0	12500	11600	2900
16	3000	0	0	10000	13600	3400
17	3000	0	0	7500	15600	3900
18	3000	0	0	5000	17600	4400
19	3000	0	0	2500	19600	4900
20	3000	0	0	0	21600	5400

Table 10.5D: Scenario #2, Area 2: Acreage by land use categories for the 20 year study period.

	OPEN	PRE-MINING		PEAT	RECLAIMED	
YEAR	WATER	DISTURBED	SHRUB	MINE	AGRIC	FOREST
0	150	1500	11700	0	0	1650
1	150	1425	11110	750	0	1565
2	150	1350	10520	1500	0	1480
3	150	1275	9930	2250	0	1395
4	150	1200	9340	3000	0	1310
5	150	1125	8750	3750	0	1225
6	150	1025	7960	4000	750	1115
7	150	925	7170	4250	1500	1005
8	150	825	6380	4500	1800	1345
9	150	725	5590	4750	2400	1385
10	150	625	4800	5000	3000	1425
11	150	500	3840	5220	3800	1490
12	150	375	2880	5440	4600	1555
13	150	250	1920	5660	5400	1620
14	150	125	960	5880	6200	1685
15	0	0	0	6100	7000	1750
16	0	0	0	4880	7970	2000
17	0	0	0	3660	8940	2250
18	0	0	0	2440	9930	2480
19	0	0	0	1220	10900	2730
20	0	0	0	0	11880	2970

Table 10.5E: Scenario #2, Area 3: Acreage by land use categories for the 20 year study period.

	OPEN	PRE-MINING		PEAT	RECLAIMED	
YEAR	WATER	DISTURBED	SHRUB	MINE	AGRIC	FOREST
0	0	780	19760	0	0	5460
1	0	750	18920	1100	0	5230
2	0	720	18080	2200	0	5000
3	0	690	17240	3300	0	4770
4	0	660	16400	4400	0	4540
5	0	630	15560	5500	0	4310
6	0	580	14350	6000	1100	3970
7	0	530	13140	6500	2200	3630
8	0	480	11930	7000	2640	3950
9	0	430	10720	7500	3520	3830
10	0	380	9510	8000	4400	3710
11	0	300	7610	8900	5680	3510
12	0	220	5710	9800	6960	3310
13	0	140	3810	10700	8240	3110
14	0	60	1910	11600	9520	2910
15	0	0	0	12500	10800	2700
16	0	0	0	10000	12800	3200
17	0	0	0	7500	14800	3700
18	0	0	0	5000	16800	4200
19	0	0	0	2500	18800	4700
20	0	0	0	0	20800	5200

Table 10.5F: Scenario #2. Area 4: Acreage by land use categories for the 20 year study period.

	OPEN	PRE-MINING		PEAT	RECLAIMED	
YEAR	WATER	DISTURBED	SHRUB	MINE	AGRIC	FOREST
0	130	910	7280	0	0	4680
1	130	860	6900	680	0	4430
2	130	810	6520	1360	0	4180
3	130	760	6140	2040	0	3930
4	130	710	5760	2720	0	3680
5	130	660	5380	3400	0	3430
6	810	610	4940	3490	0	3150
7	1220	560	4500	3580	0	3140
8	1700	510	4060	3670	60	3000
9	2180	460	3620	3760	130	2850
10	2520	410	3180	3850(140)*	190	2710
11	2790	330	2530	4230(330)	220	2570
12	3070	250	1880	4610(520)	240	2430
13	3280	170	1230	4990(710)	330	2290
14	3490	90	580	5370(900)	420	2150
15	3700	0	0	5750(1090)	390	2080
16	4010	0	0	4600(1440)	350	2600
17	4320	0	0	3450(1790)	320	3120
18	4640	0	0	2300(2140)	280	3640
19	4960	0	0	1150(2490)	240	4160
20	5280	0	0	0(2860)	230	4630

*Numbers in parentheses represent the residential areas.

10.6 Appendix for Section 6.2.1.2: Nutrient Yieilds and Surface Water Eutrophication

Table 10.6A: Land use acreages used in calculations for sections 6.2.1.2 and 6.2.1.3

Scenario #	Area	Year	Naturally-vegetated	Crop land & Actively Mined	Pasture Land	Open Water	Residential
1	1	0	15818	0	0	0	0
		10	10702	3662	0	1454	0
		20	6054	8310	0	1454	0
1	2	0	7142	0	0	0	0
		10	4420	2670	30	0	0
		20	2042	5010	90	0	0
2	1	0	30000	0	0	0	0
		10	23640	3168	285	2907	0
		20	4875	20943	1230	2952	0
2	2	0	15000	0	0	0	0
		10	11820	3123	57	0	0
		20	2460	12294	246	0	0
2	3	0	26000	0	0	0	0
		10	21280	4525	195	0	0
		20	4200	20750	1050	0	0
2	4	0	13000	0	0	0	0
		10	10127	760	53	1954	106
		20	3852	2300	214	4280	2354

Notes:

Naturally-vegetated includes reforested, buffers
Scenario #3 = Scenario #1 at years 0 and 10

TABLE 10.6B: **General Ranges of Primary Productivity of Phytoplankton and Related Characteristics of Lakes of Different Trophic Categories**[a]

Trophic Type	Mean Primary Productivity[b] (mg C m^{-2} day^{-1})	Phytoplankton Density (cm^3 m^{-3})	Phytoplankton Biomass (mg C m^{-3})	Chlorophyll *a* (mg m^{-3})	Dominant Phytoplankton	Light Extinction Coefficients (η m^{-1})	Total Organic Carbon (mg l^{-1})	Total P (μg l^{-1})	Total N (μg l^{-1})	Total Inorganic Solids (mg l^{-1})
Ultra-oligotrophic	< 50	< 1	< 50	0.01–0.5		0.03–0.8		< 1–5	< 1–250	2–15
Oligotrophic	50–300		20–100	0.3–3	Chrysophyceae, Cryptophyceae, Dinophyceae, Bacillariophyceae	0.05–1.0	< 1–3			
Oligo-mesotrophic		1–3						5–10	250–600	10–200
Mesotrophic	250–1000		100–300	2–15		0.1–2.0	< 1–5			
Meso-eutrophic		3–5						10–30	500–1100	100–500
Eutrophic	> 1000		> 300	10–500	Bacillariophyceae, Cyanophyceae, Chlorophyceae, Euglenophyceae	0.5–4.0	5–30			
Hypereutrophic		> 10						30–> 5000	500–> 15000	400–60000
Dystrophic	< 50–500		< 50–200	0.1–10		1.0–4.0	3–30	< 1–10	< 1–500	5–200

[a] Modified from Likens (1975), after many authors and sources.

[b] Referring to approximately net primary productivity, such as measured by the ^{14}C method.

(Wetzel, 1975)

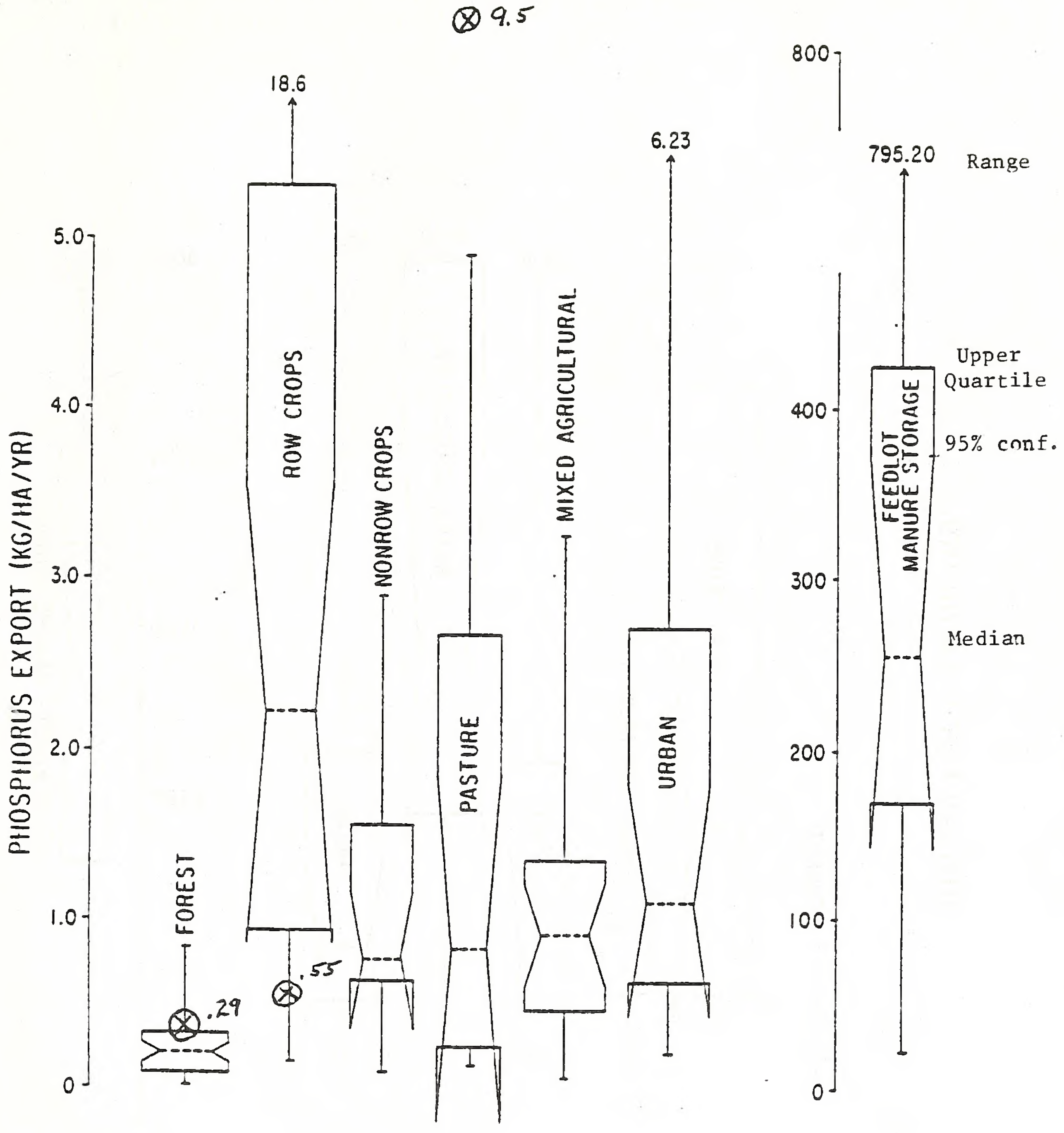

Figure 10.6A: Box plots of phosphorus export coefficients from various land uses (from Reckhow, Beaulac and Simpson, 1980)

x marks areal yields determined by Skaggs et al., 1980 and Gregory et al., 1984, for peatland systems in North Carolina

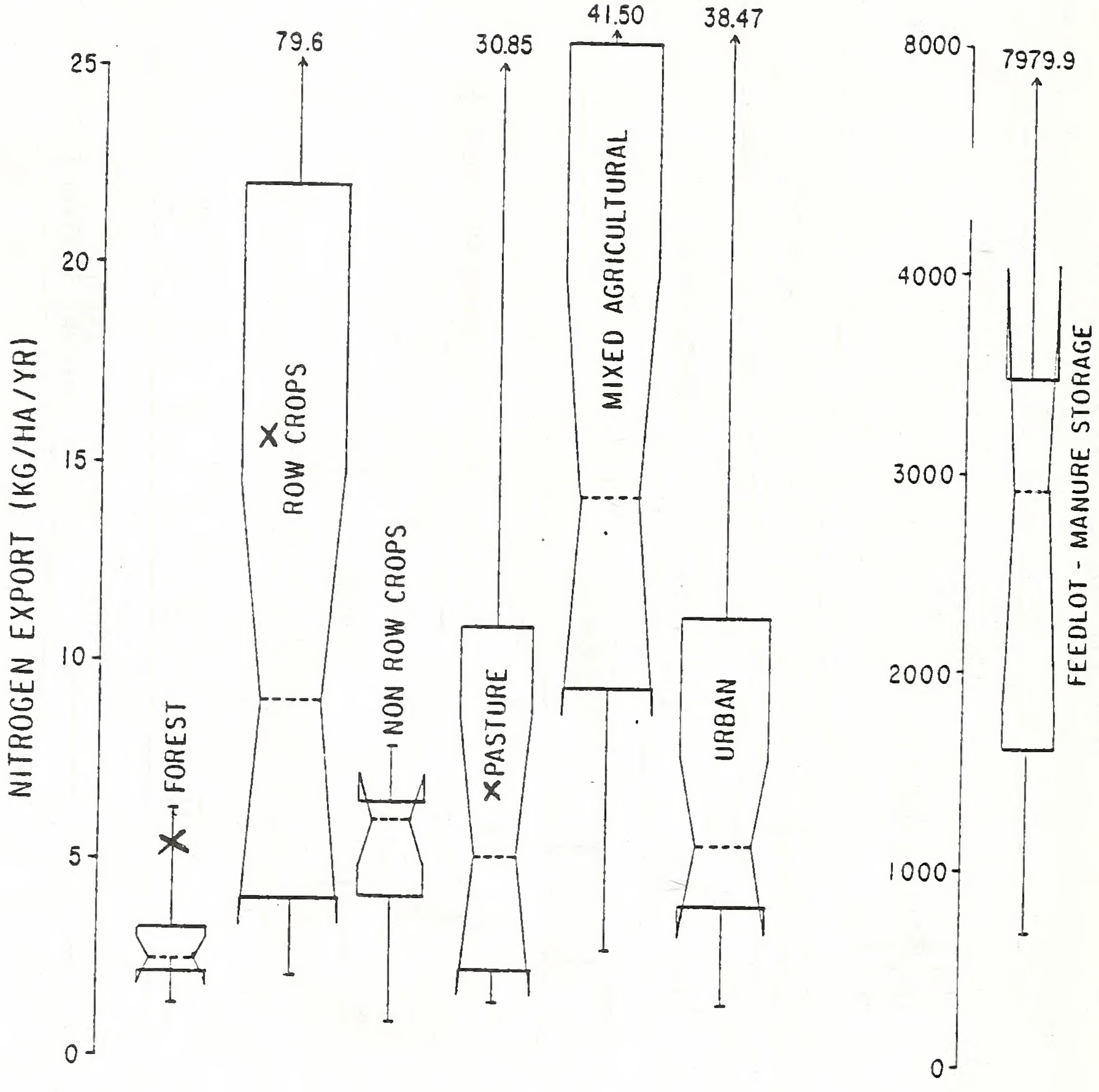

Figure 10.6B: Box plots of nitrogen export coefficients from various land uses (from Reckhow, Beaulac and Simpson, 1980)

x marks areal yields determined by Skaggs et al., 1980 and Gregory et al., 1984, for peatland systems in North Carolina

10.7 Appendix for Section 6.2.1.3: Trace Element, Pesticide and Coliform Bacteria Yields

Other pesticides currently in use in the area (Dr. J. W. Van Duyn, personal communication), and the crops on which they are used, include the following:

Herbicides

Corn and soybean, pre-emergent:

Alachlor (Lasso) - high organic soils

Atrazine - used with Alachlor in low organic soils

Linuron (no-till soybeans)

Soybean, post-emergent;

Bentazon (Basagran)

Acifluoron (Blazer)

Fuselaid

Corn, post-emergent:

2,4 D

Dicamba

Ametryn

Linuron

Small grains:

2,4 D or Dicamba (at time of N-application @ April)

Paraquat (no till)

Insecticides

Corn (1 application at planting) of either:

- Carbofuran
- Chlorpyrifos
- Phorate
- Turbufos

Soybean, mainly:

- Phorate

Late-planted soybeans typically are treated in August with either:

- Carbaryl
- Methomyl
- Fenvalerate
- Permethrin

Small grains (typically on @ 10% treated, mainly for army worms):

- Carbaryl
- Methomyl
- Malathion
- Toxaphene (being phased out)

10.8 Appendix for Section 6.4: Air Quality

Air Quality Assessment

Introduction

The air quality impacts of peat mining and utilization are impossible to predict except on a site specific basis. Model predictions require quantitative information on the flux of emitted pollutants from each source, the location of each source, the location of all sensitive receiving areas with respect to the sources, comprehensive meteorological data for the region and an appropriate mathematical dispersion model. In addition, the height above ground at which the pollutants are emitted and any ameliorating conditions must be factored into the model calculations. The cost and complexity of both data gathering and computation limit air quality model development to immediate cases of concern; long range, cumulative air quality impacts are rarely undertaken because of the additional costs and the uncertainty that exists in source location. To date, an air quality impact assessment has only been performed for that part of the Scenario 1 peat mining area operated by Peat Methanol Associates. Predicted impacts of both fugitive dust emissions during mining and pollutant emissions from methanol conversion are reported in PSD permit applications of PMA to the NC Division of Environmental Management. Because these two source types are assumed to be the same that would exist in the scaled up peat mining development of Scenario 2, this could provide the basis for development of air quality impact models involving the integrated impact of the largescale peat mining postulated in Scenario 2.

None of the companies currently considering peat mining in the region has developed such an integrated impact model. This is understandable since they are not, as individuals, knowledgeable about the specific plans of other companies and the NC State permitting process deals with PSD permit applications on an individual, sequential and incremental basis rather than planning for and partitioning allowable pollutant increments on the basis of anticipated cumulative integrated impacts.

An attempt to take an integrated view has been made in a study conducted by the firm of Rogers, Golden and Halpern, issued as CEIP Report No. 14 "Design of a planning program to help mitigate energy facility air quality impacts in the Washington County, North Carolina, area." This report has been criticized for the additive scaleup assumptions used in extrapolating impacts resulting from peat mining and conversion on 15,000 acres of land to those resulting from development eight times as large. Additional criticism has been directed at the failure to consider options for amelioration of impact that are possible through pollutant source spacing options and pollution control technologies.

Air quality standards

Relevant air quality standards have been discussed recently in CEIP Report No. 14 which specifically focused on peat mining impacts in the Pamlico/Albemarle sound area. State and Federal regulations set upper limits on permissible concentrations of specific pollutants as both annual averages and short-term maximum permissible concentrations. The regulated pollutants are carbon monoxide (Co), hydrocarbons, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), lead, photochemical oxidants (ozone) and particulates. Table 1 lists the primary and secondary standards. Primary standards are intended to protect public health; secondary standards are intended to protect public welfare. The standards differ among different class areas, two of which exist in the peat mining area. Class II areas are those thought to tolerate some degradation of air quality that accompanies normal, well-managed growth. Class I areas are more sensitive and cannot tolerate further air quality deterioration. These are often park and wilderness areas. The Swanquarter National Wildlife Refuge in Hyde County is such a Class I area in the peat mining region and it requires special consideration in assessing air quality impacts. All other areas are Class II.

In addition, regulations designed to "prevent significant deterioration" (PSD) are intended to limit increases above existing baselines in concentrations of two pollutants, SO_2 and total suspended particulates. These are listed in Table 2. These are intended to provide protection to areas with air that is currently cleaner than the ambient air quality standards by limiting additional increments of pollutants. Particulates from fugitive emissions during peat mining are exempt from PSD increment limitations.

Table 10.8A: National Ambient Air Quality Standards

Finally it is required that visibility (which is primarily a function of particulate concentrations) should not be reduced in Class I areas.

Pollutant	Primary µg/m^3 (ppm)	Secondary µg/m^3 (ppm)
CO		
80 hr Max	10,000 (9)	same
1-hr Max	40,000 (35)	same
Hydrocarbons		
3-hr Max (6-9 a.m.)	160 (0.24)	same
NO$_2$		
Annual Arithmethic Mean	100 (0.5)	same
24-hr Max	250 (1.25)	
Photochemical Oxidants (ozone)		
1-hr Max	235 (0.12)	same
Particulates		
Annual Geometric Mean	75	60
24-hr Max	150	150
SO$_2$		
Annual Arithmetic Mean	80 (0.03)	--
24-hr Max	365 (0.14)	--
3-hr Max	--	1300 (0.5)
Lead		
3-mo Max	1.5	same

Table 10.8B: Maximum Allowable increases under prevention of significant deterioration (PSD) regulations

Pollutant	Micrograms per cubic meter
CLASS I	
Particulate Matter	
Annual Geometric Mean	5
24-hr Maximum	10
Sulfur Dioxide	
Annual Arithmetic Mean	2
24-hr Maximum	5
3-hr Maximum	25
CLASS II	
Particulate Matter	
Annual Arithmetic Mean	19
24-hr Maximum	37
Sulfur Dioxide	
Annual Arithmetic Mean	20
24-hr Maximum	91
3-hr Maximum	512

Uncertainties in Estimates of Fugitive Dust Emissions

There are large uncertainties that must be associated with these estimates. In part this results from the empirical nature of the source emission models. Most of these were derived from coal storage models which may not be appropriate to peat. In particular, dried peat will likely have a much lower bulk density than coal and thus be more easily resuspended by wind and held in suspension more easily.

In addition, although some conservative assumptions have been included in the PMA analysis, there are several assumptions that tend to minimize estimates of fugitive dust emissions. First, it is assumed that the fields will be tilled 16 times each year in order to remove 16 inches of peat for drying, at one inch increments. However, PMA's Draft Environmental and Occupational Health Monitoring Plan Outline states that the milled peat harvesting process removed only as much as 7% of the peat moisture with each turn to a depth of 4 inches. To reduce moisture from 81% to 40% would require a minimum of about 6 turns or 24 per year to mine 16 inches depth. There will be a separate milling process associated with each turning which could resuspend additional peat.

Second, fugitive dust emissions are assumed to occur only during tilling (i.e. turning). However milled, dried peat will lie on the surface in what is described as a "thin fluffed layer" that should be easy to resuspend by wind erosion. This may be as important a source of fugitive dust emissions as tilling.

Third, field storage piles (1 mile by 70 feet by 10 feet high) are assumed to behave as coal storage piles in terms of dust emissions. As mentioned earlier this may not be the case. Also, a seeming impossibility exists in the emission model equation used by PMA. Wind erosion from storage piles is calculated to be proportional to the average peat pile turnover in days (33 days in PMA's case). If the piles are never turned over (i.e. utilized) the turnover time is infinite and the emission rate is, therefore, also infinite. This cannot be true. In addition model calculations made by PMA assume an 80% reduction in emissions due to wind speed control using screens. There is no adequate justification for the choice of this reduction factor. Such screens would need to be taller than the 10 foot height of the piles to be effective and would probably need to be on both longitudinal sides of the storage pile to be effective. If wind screens are not used or are not as effective as assumed above, dust emissions from storage piles would be substantially increased.

Last, the dust emissions resulting from truck traffic will vary with the average round trip distance travelled along unsurfaced roads between field storage piles and plant storage. PMA has used an average round trip distance of about 3 miles to calculate inputs for subsequent dispersion modeling. However, the choice of initial and worst case harvesting locations are all clustered around the methanol plant peat storage sites. If the whole 15,000 acre PMA site and other sites of Scenarios 1 and 2 are to be considered, round trip transport to either a methanol processing facility or transshipment points for offsite use will certainly be greater with consequently greater fugitive dust emissions.

It is worth noting that CEIP Report 14 cites a paper by Ertugrul and Sober (1979) that fugitive dust emissions during peat harvesting could be as high as 10 percent of the total peat harvested. This is equivalent to 96,000 tons per year based on the 1900 acre/yr mined under the assumptions of PMA in Table 5.4A. Although this seems unrealistically high and the assumptions leading to the 10% figure are not immediately available, it points to the same two conclusions previously reached: First, there are serious uncertainties in our estimates and our ability to estimate fugitive dust emissions during peat harvesting and second, existing estimates by PMA may be too low. There is an obvious need to refine these estimates if the emission inputs used in air quality dispersion models are to be of any use.

Critical receptors

Two critical receptor types exist in regard to air quality impacts. First is the offsite boundary of the peat mining and processing facility, where air quality deterioration would first impact the general public. There are an infinite number of possible receptor points along the peripheral boundary of any peat mining operation. As harvesting operations shift throughout any permitted mining area, different points along the periphery become the most sensitive receptors. This complicates most modeling efforts. Worst case analyses can probably set upper limits on impacts.

Second is the Class I area of the Swanquarter National Wildlife Refuge, which is a more sensitive receptor. Given the distance from the PMA (~27 km) site and most other proposed mining areas, it could probably be modeled as a single point receptor for each proposed mining area which could, in turn, be approximated as individual point sources. An exception might be Area II of our Scenarios which lies nearest to Swanquarter NWR and which lies approximately NNW of Swanquarter, the direction from which the dominant wind blows during the September to November season. More detailed modeling of this source/receptor pair might be necessitated as a result.

In addition, the Mattamuskeet and Pungo Lake National Wildlife Refuges, although not Class I Areas, should perhaps be considered special receptors. The impact of peat derived particulates on visibility at Pettigrew State Park (Phelps Lake) should also be considered for special treatment.

Monitoring Requirements

CEIP Report No. 14 has considered extensively the needs and purposes of air quality monitoring in relation to peat mining and use in the area. Their evaluation and generally sensible recommendations will be quoted verbatim in what follows.

"Need for Monitoring

"Air quality monitoring is an essential component of an air quality maintenance/air pollution control program. Monitoring provides the information needed to judge compliance with air quality standards and chart trends or changes in air quality. In order for an air quality monitoring network to provide the required data, the design of the network must take into consideration factors such as existing pollution levels, meteorology, topography, population, and source distribution."

"The purpose of this chapter is to present several basic concepts and requirements to be considered in upgrading the existing monitoring system to track more closely the air quality impacts of peat mining and various end uses in eastern North Carolina. Suggestions on the future placement of air quality monitors will be offered. These monitors will augment the existing State network to keep closer surveillance on emissions from peat mining, transportation, and combustion, as well as conversion to peat methanol. In addition to regional surveillance, the use of specially designed intensive monitoring programs will be suggested to improve knowledge of particulate emissions characteristic of various peat mining, transportation, handling and storage activities."

" Operation of the State monitoring network is the responsibility of the Division of Environmental Management (DEM). The Division operates twelve monitors that sample the air continuously as well as seventy-two manual monitors that sample the air for a 24-hour period once every six days. In the vicinity of the study area, there are only three DEM air quality monitoring stations: Plymouth (SO_2, NO_2 and particulates); Washington (particulates); and Elizabeth City (particulates)."

"The existing State network is clearly inadequate to document air quality and trends in the study region, yet the air quality impacts of peat mining must be monitored in order to protect the area's natural resources and to ensure compliance with Federal and State environmental standards."

"A new monitoring system must be designed to complement the existing system. Effective resource management and the design of an effective monitoring system require a knowledge of the overall physical and ecological systems in the region where peat mining is now or will be occurring. Planners need to know about the components of the natural system, their natural variability, and vulnerability to disruptions caused by peat mining and reclamation, and the critical threshold levels beyond which a problem is created. Knowledge of all these elements is difficult to obtain, as the area in which peat mining is ongoing or contemplated is an isolated one, about which little has been documented."

"Any new monitoring system to be constructed must serve the following purposes, at a minimum:

- "Record compliance of peat mining and development activities with existing environmental standards;"
- "Provide information for general protection of the Class I area (Swanquarter Wildlife Refuge), as well as the sensitive areas of Lake Phelps and Pungo Lake;"
- "Provide information to determine the need for changes in environmental standards, permit conditions, or mitigation design; and"
- "Provide information to more accurately quantify emissions from peat-related activities to make possible more accurate prediction of the effects of future development."

"Monitoring of Regional Background and Trends

Good definition of regional air quality will require installation of at least two air quality monitoring stations.

"One station should be located within the boundaries of the Class I area and the other should be located just downwind (to the east or northeast) of the active and proposed mining areas between Pungo Lake and Lake Phelps. The purpose of the Swanquarter monitor would be to determine current ambient air quality. Since the Swanquarter National Wildlife Refuge has been designated by the Federal government as a Class I area, the level of ambient particulates cannot be increased more than 5 micrograms per cubic meter as an annual geometric mean or 10 micrograms per cubic meter as a 24-hour average over the baseline. Similar, highly restrictive limitations apply to SO_2. ... There has not been any air quality monitoring within the Refuge, so accurate determination of the "baseline level" of ambient particulates or any of the other criteria pollutants is impossible. If the air quality of the Refuge is to be protected in the face of projected regional development, sampling must be initiated to establish the baseline air quality. However, such a monitor would not likely be capable of providing increment tracking information or dispersion modeling for increment consumption in that monitors are unable to differentiate between impacts from those sources consuming increment and variations in impacts from existing baseline sources."

"The overall purpose of the second monitoring station is to quantify air quality in the heart of the region near Lake Phelps and Pungo Lake."

"LAKE PHELPS is a sensitive area that may be adversely affected by peat operations. Lake Phelps borders the area where First Colony Farms and others are now or will soon be mining peat.

The sensitivity of this area tends to support the location of a monitoring station near Lake Phelps, at a location downwind from peat mining operations.

PUNGO LAKE, a 12,350-acre National Wildlife Refuge, is another sensitive natural area within Washington County that the County feels should be preserved in the future for scientific, ecological, educational, and recreational purposes. The lake has been designated as a wildlife refuge because of its importance as a wildlife habitat, its representation of a protected pocosin ecosystem, and its illustration of geologic and geomorphic processes. Its proximity to present and proposed peat mining areas supports the placement of monitoring devices in the vicinity.

Data collected by this second monitoring station will serve three useful purposes. First, when winds are blowing from the peat mining areas and fuel conversion plant toward the monitors, this station will record the general air quality impact of the aggregate of these activities. Second, when winds are from other directions, this station will be used to determine the true background pollutant levels for the study region. These background values may well be substantially different from the EPA values heretofore assumed. The third use of data from this station will be to monitor the trends in air quality caused by expansion or an increase in the number of nearby sources. In this manner, modeling need not be relied upon exclusively to keep track of increment.

In addition to augmentation of the existing State network for purposes of documenting overall regional air quality, implementation of special purpose particulate monitoring systems should also be considered. The primary purpose of such systems would be to determine fugitive emissions and their associated impacts. Reliable fugitive emissions factors simply do not exist for many peat-related activities. Studies should be designed to determine emission factors as functions of wind speed, moisture (precipitation, evaporation, and relative humidity), and activity (vehicles per day or tons of material handled) for the following:

- o Peat mining,
- o Peat transportation, and
- o Peat handling and storage.

The emission factors developed for these activities must include mass emission by particle size to be successfully used in dispersion modeling

Since the operation of monitoring programs entails some considerable expense, the responsibility for their implementation and maintenance should be shared by the applicants for peat mining and other peat-related licenses. The Department of Environmental Management anticipates that a monitoring network will eventually need to be established, and that a significant portion of the monitoring will likely have to be performed by the mining operators. The Division's approach to monitoring peat mining impacts is to allow limited initial mining to proceed while affording the opportunity to evaluate the mining impacts. From these evaluations, operational conditions and monitoring requirements can be applied to future permits or renewals. Currently, Air Quality Permits issued to peat mining operations are only issued for one year.

Compliance monitoring can also be required under the State's Mining Act of 1971. Although the phrases "unduly adverse" and "significantly adverse" are used in the Mining Act in reference to effects on wildlife, fisheries, and publicly-owned parks, forests, and recreation areas, there are no concrete standards attached to these phrases. Revision of the Mining Act may be needed to quantify these standards, thus allowing lack of monitoring to be cited as a reason for denying mining permits.

For the purpose of studying PSD increment consumption by sources that could potentially locate in the region, it will be necessary to determine the amount of increment remaining at various receptor locations in both the Class I and Class II portions of the study region. This will require compilation of a special source data base (inventory) of emission changes both inside the region and at sources outside the region but having a significant effect upon the region.

Model Validation/Calibration

Accuracy of dispersion model predictions is generally considered to be within a factor or two of the actual concentration. Modeling accuracy lessens as source-receptor distance increases or as influence of topographical features that violate model assumptions (such as nearby significant bodies of water) become important. Both of these problems leading to accuracy degradation are present when ISC is used for predictions in the Class I area. The most restrictive Class I SO_2 PSD increment is less than 2 percent of the corresponding NAAQS. This almost infinitesimally small concentration increment is extremely difficult to predict accurately. It is almost beyond the current state of the art. In addition to the factor of two uncertainty generated simply by modeling theory and assumptions, other sources of possible inaccuracy are present. A modeling analysis can be no more accurate than the input source emissions data. Sources not included in the inventory that are actually present, sources that are included but are actually defunct, and errors in emissions or stack data may seriously degrade the modeling.

For all the above reasons, a validation of modeling results for the Class I area is considered an absolute necessity. A validation program using quality assured monitored data and emission information from the sources now affecting the Class I area should be developed. Calibration of ISC for the study region may be possible if the validation results are disappointing.

10.9 Appendix for Section 6.7: Local Economics and Employment

SOCIO-ECONOMIC IMPACT ANALYSIS

Large-scale developments have the potential to greatly affect a region's people, communities and governmental institutions. For developments that are resource based, and for developments that occur in sparsely populated agricultural areas, the potential for important impacts is especially great. Peat mining in North Carolina possesses both these attributes. The socioeconomic analysis in this report is designed to: (1) establish a general framework for analysis of the social and economic impacts of peat mining in North Carolina and (2) estimate those impacts to the extent possible given the time constraints placed on this study and the general lack of available data necessary for a full understanding of peat mining impacts. This Appendix expands somewhat on the procedures in the basic report but does not present again those results provided in Section 5.8.

It is useful to separate economic impacts into two components: (1) private sector impacts and (2) public sector impacts.

Private Sector Impacts

Through production of output that is demanded locally and/or nationally, peat mining will create jobs and provide income through salaries paid to workers and through increased demand for materials from input and service supplying businesses. These are often called the direct effects of an expansion of an industrial sector.

In addition, these direct effects lead to additional income-generating effects: (1) through wage earners spending of money received from their employment at the new or expanded industry and (2) through direct suppliers purchasing additional materials and hiring labor in order to provide the inputs and materials to the peat mining industry. These are often called indirect effects. More specifically, the trickle-down cumulative impact of wage earners spending their money is often called the consumer indirect effect, while the trickle-down cumulative impact of purchases of inputs is called a producer indirect effect. In cases where wage earners spend a large proportion of their earnings locally, and where input purchases are made locally rather than from producers located great distances from the site of the new industry, the indirect income and employment impacts can be substantial. It is important to understand that the economic impacts of peat mining on the private sector is not limited to their payments of wages to employees nor to purchases of supplies to construct and operate the peat mining facility

Direct employment and income effects are normally estimated from studies relating the value of the output of the new industry to its projected employment and wages paid, and to projected expenditures for construction or operating materials. Indirect employment and income effects are typically estimated using input-output models that provide output employment and income multipliers by which peat mining output levels can be multiplied to obtain the desired "trickle-down" consumer and producer indirect effects. Alternative output levels can be developed from phasing of plant capacity schedules or plans and scenarios of multiple industry possibilities.

Public Sector Impacts

Economic growth and development affects the fiscal affairs of local government by providing revenue and by causing government to incur additional expenses. On the revenue side, the process of constructing and operating the peat mining facility will provide revenues for the operation of state and local government. Currently included in North Carolina are, for example, business and personal property tax, sales tax, utility franchise tax, intangible personal property tax, motor fuel tax, corporate and personal income taxes, unemployment taxes and inventory taxes. Some of these taxes go to the state and others are paid to counties and cities. The amount of these funds available locally depends upon how taxes are administered locally and upon how the state shares with local government the taxes it collects. An additional factor is whether a severance charge is assessed and, if so, how it is distributed. In addition, new residents in the area will be assessed sales taxes on purchases and property taxes on homes and personal property. Taken in sum, this revenue is available to pay or help pay for the public service and facilities costs local government incurs as a result of the development of the peat mining industry and the new residents it attracts.

The fiscal cost impacts of growth and development upon the public sector are understood or acknowledged to a lesser degree than are the private sector income and employment impacts, because of the less obvious (on the surface) tie between the arrival of new workers and families and the demand for public services and facilities they create. However, these costs and benefits are just as real and must be estimated to fully understand the total impact of the peat mining industry on coastal North Carolina residents.

Public service and facilities costs depend largely upon the influx of new residents (workers and families) resulting from the construction and operation of the peat mining facility. This, in turn, depends upon the level of direct and indirect employment generated by the facility, the level of unemployment and skills available within the area, the labor force participation rate, the extent to which workers currently employed and living elsewhere commute to the peat mining facility rather than relocate their residence, and family composition of the new residents (size of family, number of children, whether both spouses work, etc.). Community service impact models can be constructed at various levels of detail to estimate these impacts.

In the public sector, the issue is not whether the peat mining facility provides revenue to or generates costs for local government. It is clear that both costs and revenues will be generated. Rather, the issue concerns the net balance, that is, whether or not the public costs generated by the peat mining activity are offset by revenues generated. Both short-run and long-run time frames must be analyzed. Further, it is essential to know the cumulative effects of the development since multiple developments may occur in which case the impact of the sum of all activities may exceed the sum of the individual parts.

Long-run Impacts[1]

Long-run impacts are those that have occurred after the economy has had a chance to fully adjust to the new activity and which are expected to be long lasting. Two types of impacts are considered: economic impacts and fiscal impacts.

Economic Impacts

Stimulation of the economies of Tyrrell, Hyde, Washington and surrounding counties is assumed to occur because of rising demand for the final products of the peat mining industry. Increased demand for these exportable goods leads to direct and indirect employment and income increases in those counties and, perhaps, in other counties as well.[2]

The estimates presented in Section 5.8 are based upon a number of assumptions and upon data that may or may not reflect what might result in reality if the plant were to be constructed. Although this is the nature of any study of such a type because of the highly speculative and uncertain nature of key pieces of data, the roughness of the estimates should not be underestimated. Many of PMA's assumed coefficient levels were used for the direct plus indirect impact without verification. Also, the 1.55 income multiplier derived in a coal mining study but used here may not be accurate for peat mining. Without the benefit of time for an in-depth study and analysis, these assumptions are the best available. Nevertheless, it can be said that the PMA study ignores the indirect effect of constructing the peat mining facility and, thus, underestimates the long-run employment, population and income effects of the facility.

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[1] This report has benefited greatly from the work of Stinson, et al. [1982].

[2] Although the focus of the scenarios is upon Tyrrell, Hyde and Washington Counties, the economic impact will extend far beyond those counties. PMA assumes workers will commute 1 hour 15 minutes to work on the project, thus affecting 12 counties. The PMA Socioeconomic Analysis uses a study area of 10 counties and, since this section is heavily dependent upon their data, the same is used here.

It might also be worthwhile to note that the information available in the PMA study does not lend itself to providing the type of income estimate normally derived from an input-output model. That is, the income estimate from PMA is the retail sales volume generated by the spending of new workers and their families, whereas an input-output model uses the value of output from the new industry. In the latter case, changes in output level (assumed to be generated by increased demand for its products) works through the sectoral interdependencies in the model to provide estimates of changes in total area income including indirect employment and income from the industries providing services and supplies to the mining activity.

Fiscal Impacts

Net revenues going to local governments as a result of peat mining may exceed the costs of services and facilities demanded by new residents. On the other hand, three types of developmental problems might confront local governments in the impacted area. First, long-run fiscal problems may arise in cases where a local government must provide expanded services and facilities but is unable to tax the new facility. This is a spillover problem where new residents locate outside the political boundaries of the local governments that have the power to tax the facility. Thus, costs of facilities and services to meet demands of residents are incurred without receipt of offsetting tax revenue. Second, even if long-run benefits were to exceed costs, there may arise front-end or short-run fiscal problems where revenues generated lag cost incidence. For example, local government may need to increase the school budget immediately upon arrival of new residents, whereas tax revenues generated by those residents or from the peat mining facility itself will be lagged 1, 2 or more years beyond that time. A short-run cash flow problem will thus arise. Third, the cumulative impacts of peat mining must be studied. To some extent, the scenarios address different levels of development and, thus, go beyond estimation of the impacts of a small-scale test facility. However, if developments beyond current expectations were to be attracted, impacts will likely increase geometrically rather than arithmetically. For example, fiscal costs could increase geometrically as excess capacity in the school systems is exhausted, as full employment is reached, or as the road system becomes overloaded. Many of these costs may not arise with a small facility. The report of the Peat Mining Task Force [1983] indicates that success initially could lead to a three- to eight-fold expansion of plant capacity. If such is a possibility, an in-depth study of the cumulative impacts is required.

Fiscal impacts will vary by county and city in the 10-county area. Taxes of several categories will be contributed directly or indirectly by the peat mining facility: business property taxes; unemployment taxes; intangible property taxes; inventory taxes; corporate franchise taxes; sales and use taxes; and income taxes on wages and proprietory income. However, the distribution of these local and state revenues to individuals and counties will vary greatly. For example, Washington County will receive the bulk of the property taxes, estimated by PMA to be $900,000 per year. Municipalities and other counties may receive little. Many of the tax categories are paid directly to the state. How and to what extent they are distributed to impacted counties and municipalities will partially determine whether the net fiscal impacts are positive or negative.

The demands placed on various local governments by new residents will vary in similar fashion. It is estimated by PMA that Chowan and Washington Counties will receive most of the influx of new residents. Yet, Washington County will likely receive the largest share of revenue generated by the facility. Chowan County, and particularly the City of Edenton where many new residents will probably reside, will receive much less. Other examples could probably be identified with further study. Thus, while a major issue is simply whether long-term benefits of peat mining exceeds its costs, the distribution of those costs and benefits is of equal importance to the citizens of the cities and counties throughout the impacted area.

The PMA study generally cites an adequacy of public facilities and services available to meet the demands of the new residents. This conclusion deserves a review for two reasons. First, the underestimate of total employment generated by the peat mining facility suggests that the demand placed upon public facilities and services is also underestimated. In some cases, the excess capacity may be exhausted requiring new public investments. For example, the increased number of students may require an additional school, especially if the influx of students is concentrated in only two areas, Washington and Chowan Counties. Further, even if facilities are adequate, several new teachers will likely need to be hired, and each new pupil will need to be supported.

The fiscal impacts of peat mining require an in-depth analysis of the amount and distribution of costs and revenues between counties and cities throughout the impacted area. Unequal distribution may lead to increased taxes in some areas while at the same time providing great surpluses in others. Cities especially may not fare well fiscally, because they can be expected to bear a large proportion of the demand for new services and facilities, yet receive little property tax revenue because the mine will lie outside of their taxing jurisdiction. However, full understanding of the potential for these problems requires an in-depth analysis of state aid formulas and city and county assessment policies and expenditure patterns.

Short-run Impacts

Short-run impacts are more difficult to estimate than long-run impacts, because a year-by-year schedule of costs and benefits must be estimated rather than selecting a single year in the future as is the case for long-run impacts. However, the year-by-year assessment is essential, because tax revenue generally lags the demand for services and facilities, and cash flow problems for local government may result. For a large-scale facility such as planned, the short-run impacts can be significant, because the number of construction workers greatly exceeds permanent employment after the plant becomes operational. Thus, the number of employees peaks during the middle of the construction period, while tax revenues peak after the plant becomes operational.

As with the long-run economic impact, it is desirable to estimate both direct and indirect employment and income effects of facility construction. However, two key differences in the short-run and long-run impacts are (1) the short-run impacts must be calculated on a yearly basis and (2) the short-run employment and income multipliers are less than the long-run multipliers, because input supply and consumer service industries will not develop due to the short-term nature of the demand for their services. It would not pay to invest in service facility construction if the number of workers would be greatly reduced in 2.5 to 3 years or less.

Data are not readily available to estimate the short-run multipliers necessary for estimating service employment and income to add to the direct impact of construction workers. However, the proportional underestimate of the total economic effect is likely somewhat less than was the case for the long-run impact analysis.

Because of the large number of tax categories and because estimates of direct plus indirect employment are unavailable, it is impossible to project whether or not a short-run fiscal problem in certain areas may exist. However, conclusions reached by PMA that sufficient excess capacity exists in the area to eliminate the need for large, new expenditures for many public services appear reasonable in most cases. However, operating budgets for some services will increase while capital expenditures may need to be speeded up for others. School budgets will need to be larger even though facilities may be adequate. Improvement and expansion of sewer and solid waste disposal facilities may require added funds in some localities based on data in PMA's study.

As with the long-run impact, the distribution of costs and benefits will be important. Some areas will experience revenue shortfalls, while others will experience surpluses.

Estimation of demands for services requires an input-output or community service impact model to determine the interrelationships between industries and areas and the appropriate multipliers.

Summary

In summary, the socioeconomic impacts estimated for this study, while they are the best that could be developed given the time available, should be used with care. In all cases, they should be considered preliminary estimates because (1) they are based on secondary data currently available for the area or (2) they are data developed in studies of mining in other areas of the country. Nevertheless, it has been demonstrated that peat mining will have substantial social and economic impacts on a large portion of northeastern North Carolina, especially because of potential inequalities in the distribution of benefits and costs to different local areas. Further, the framework required for a more in-depth analysis, one that would provide the data needed, has been demonstrated.

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10.10 Abbreviations Used in the Report

Table 10.10A Abbreviations used in the report

ac	acre
ac-ft	acre-foot
Ag	silver
AP	American Peat Company
As	arsenic
BACT	bacteria
Be	beryllium
BMP	Best Management Proctice
BOD	biochemical oxygen demand
BOD5	biochemical oxygen demand - fuve day
BTu	British Thermal unit
bu	bushel
Ca	calcium
CAMA	North Carolina Coastal Area Management Act
Cd	cadmium
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second
Cl^-	chloride
cm	centimeter
CN^-	cyanate
Co	cobalt
CO	carbon monoxide
COD	chemical oxygen demand
COS	carbonyl sulfide
Cr	chromium
Cu	copper
DEM	Division of Environmental Management
DMF	Division of Marine Fisheries
DO	dissolved oxygen
DS	total dissolved solids
ECU	East Carolina University
Elev.	elevation
EPA	U. S. Environmental Protection Agency
ESE	Environmental Science and Engineering
evapotr.	evapotranspiration
Fe	iron
Fl^-	fluoride
ft^3	cubic feet
gal	gallon
gpd	gallons per day
G.S.	General Statutes
ha	hectare
HEP	Habitat Evaluation Procedure
Hg	mercury
hr	hour
HSI	Habitat Suitability Index
HS	hydrogen sulfide

in	inch
IWW	Intracoastal Waterway
kg	kilogram
Kjeld-N	Kjeldahl nitrogen (total nitrogen)
l	liter
LD_{50}	lethal dose (50% mortality)
LQ	Land Quality Section, Division of Land Resources, NRCD
M^3	cubic meter
max	maximum
Mg	magnesium
mg	milligram
mg/l	milligrams per liter
mgd	million gallons per day
mgt/mgmt	management
mgy	million gallons per year
mi	mile
mi^2	square mile
ml	milliliter
Mn	manganese
MSL	mean sea level
μg	microgram
N	nitrogen
Na	sodium
NC	North Carolina
NCSU	North Carolina State University
Neg	negligible
NH_3	ammonia
NH_4	ammonium
Ni	nickel
NNE	north-northeast
No./100 ml	number per 100 milliliters
NO_2	nitrite
NO_3	nitrate
NPDES	National Pollutant Discharge Elimination System
NRCD	North Carolina Department of Natural Resources and Community Development
NWR	National Wildlife Refuge
Ortho-P	orthophosphate
P	phosphorus
Pb	lead
perm	permanent
PF	Peat Fuels, Inc.
pH	a measure of acidity
PMA	Peat Methanol Associates
PNA	primary nursery area
PO_4	phosphate
ppb	parts per billion

ppm	parts per million
PSD	Prevention of Significant Deterioration
R	river
RR	railroad
Rte	route
Sat	saturation
Sb	antimony
SCN^-	thiocyanate
Se	selenium
S.E.	standard error
SO_2	sulfur dioxide
$SO_{4=}$	sulfate
SO_x	sulfur oxides
SSE	south-southeast
SSW	south-southwest
T	time
temp	temporary
TN	total nitrogen
tons/yr	tons per year
Tot. Org. N	total organic nitrogen
TP	total phosphorus
TPY	tons per year
TSS	total suspended solids
UNC	University of North Carolina
U.S.C.	United States Code
U.S.G.S.	U. S. Geological Survey
WTF	Whitetail Farms
yr	year
Zn	zinc

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